PAUL, REICH & MYERS, P.C.
By: Robert E. Paul, Esquire
Identification No. 21252
1608 Walnut Street, Suite 500
Philadelphia, PA 19103
(215) 735-9200

Attorney for Plaintiff

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF PENNSYLVANIA

ROBERT J. KRAUS and MARGARET M. KRAUS, h/w	: CIVIL ACTION
vs.	:NO. 18-CV-2119
ALCATEL-LUCENT, et al.	:ASBESTOS CASE

ANSWER TO LOCKHEED'S MOTION FOR SUMMARY JUDGMENT

1. Denied. Lockheed's predecessor purchased the GE/RCA product lines at issue in the case.

2. (a) denied.

   (b) denied,

   (c) denied.

   (d) denied.

Further, Lockheed ignores its responsibility for asbestos on SPS-40 and on the GE/RCA equipment.

3. Denied in that Pennsylvania law also applies and conspiracy is involved.

4. Denied.

Wherefore, the motion of Lockheed should be denied. Having failed to assert in the motion to claim that it is not responsible for its own SPS-40 or for the GE/RCA products it has conceded its liability for those claims against it.

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By: ______________________________
ROBERT E. PAUL

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MEMORANDUM OF LAW

I. GENERAL OVERVIEW OF THE FACTS

Defendant Lockheed Marin Corporation is the successor in interest to Lockheed Electronics formerly Stavid Engineering (Exhibit A). This company manufactured the SPS-40 (Exhibit B) an antenna. Kraus testified that he was the electronic materials officer responsible for all the equipment involved with electronics (Exhibit C, NT 26) including periodic maintenance. He was involved with all the equipment including radios (181). The SPS-40 was like the other radios in the shop because it had both a transmitter and a receiver (209). Plaintiff testified that he was near repairs to the SPS-40 and that it was the most modified piece of equipment on the ship (Exhibit C, 209-210). He recalled a Lockheed field representative helped repair the SPS-40 (Exhibit C, 210). The SPS-40 was worked on “a lot” (Exhibit C, 215). The SPS-40 had tubes. On the discovery deposition (Exhibit D, 164) Kraus reiterated that there were lot of problems with the SPS-40. While he only recalled one specific occasion he was next to

the SPS-40 it was always causing trouble. From this testimony it is a clear and proper inference that he was near the SPS-40 regularly. Many of these problems involved the circuit board (215). Circuit boards contained resistors and capacitors. Gossett, who was the chief petty officer noted that pieces of the SPS-40 had to be worked on (Exhibit E, 97). Gossett discussed how all the electronic equipment which would include the SPS-40 was opened monthly and the internal parts had frayed and turned to dust given the high heat (Exhibit E, 49-73). Shown a picture of the SPS-40 (Exhibit E), Gossett noted it was a complex piece of equipment (98). The base of the antenna was in the bottom of the ship where the electrical components. There were 4 boxes as can be seen from the picture of the SPS -40 system. The boxes for the SPS-40 contained transceivers, resistors, capacitors, wire and cable (NT 100). Kraus's job included monitoring work on the SPS-40 (101). It required so much work due to it being new that tech reps from Lockheed the company had to come out to help solve problems (102). While there were later iterations the only version of the SPS-40 during Kraus' time on the ship was the original SPS-40 (149). Landrum (Exhibit F) testified that there were 4 control boxes for the SPS-40 in the bottom of the ship (59-60). It had resistors, capacitors and a conduction coating (160). Unlike other equipment it was repaired where it was on the ship. Kraus job was to supervise work on the SPS-40 (83) as well as the other products the technicians worked. As Gossett had testified with respect to other capacitors and resistors repaired in the shop that they were high temperature products which caused the internal components to turn to dust (Exhibit E, 49, 60-67). The standard of the time was that resistors and capacitors contained asbestos (Exhibit G). Thus, since the SPS-40 was always being worked on by crew and by the Lockheed tech representative in Kraus' presence the asbestos-containing resistors and capacitors and condensers were opened and exposed to the air and emitted respirable asbestos dust when opened just like the other

electronic equipment in the shop on a regular and frequent basis near him. The electronic equipment on these types of asbestos products has been known to give off asbestos since the 1940's (Exhibit H). Further, Lockheed appears to have lost or destroyed the Technical Manual for the products based on its discovery answers. Plaintiff seeks an adverse inference that the Manual would have confirmed asbestos inside the 4 boxes of the SPS-40.

At the same time plaintiff was exposed to the SPS-40 he was also exposed to GE and RCA products on the ship in the electronic shop.

GE made the following products which the archive records of co-workers or both showed were used on the Cambria (SPA-4, UQN-1C, SPS-8, UPX-12)(Exhibit I). Plaintiff incorporates under F.R.C.P. 10 the answer to GE's motion.

RCA made the following products which the archive records or co-workers or both showed were on the Cambria (PRC 8-10, SRR-11, SRT 14-16, TCC-2)(Exhibit J). After the Navy he worked for some years at the GE plant at 32nd and Chestnut in Philadelphia. This plant had received an asbestosis claim in the 1930's (Exhibit K) and the pipe fitter, Covalevski (Exhibit L) descried how much asbestos there was in the facility although Kraus appears not to have known this fact. Subsequent to his exposure on the Cambria GE acquired RCA. This is undisputed. Later GE sold the electronic business to Martin Marietta, a predecessor of Lockheed Martin (Exhibit M). This sale included the assets of the GE facility at 32nd and Chestnut where plaintiff worked. The Chestnut Street facility was part of GE's Aerospace sector. In the agreement certain provisions are relevant and appear according to GE to transfer the liability to Lockheed's predecessor.

GE has not agreed it is responsible for GE and RCA products on the ship and the GE premises at issue but has not expressly disowned responsibility either. The Court must decide

whether a jury question exists on the responsibility or whether it is clear GE or Lockheed is responsible for GE/RCA products and premises. Under either circumstance Lockheed is still liable for the SPS-40. That product like all others contained electronic parts that contained asbestos and had to be opened releasing dust Kraus breathed on a regular and frequent basis.

II. ARGUMENT

The first issue here is that Lockheed is responsible for the SPS-40. This piece of equipment was an antenna that extended from the top of the ship into the interior of the ship. As plaintiff noted, it was one of the most important pieces of equipment on the ship because it could spot enemies at a great distance. At the bottom, inside the ship, it had 4 boxes filled with electronic components such as resistors and capacitors and wire. There were constantly opened releasing dust near Kraus. While Kraus was not required to work on the equipment it was his job to supervise work while it was being performed. This work included regular preventive maintenance as well as repairs which were fairly regular on the SPS-40 more so than other equipment. The standard for the components was to contain asbestos. When opened, all electronic components frayed and turned to dust due to the high heat. Kraus recalled inhaling dust in the process and Gossett and Landrum confirmed that dust was emitted each time the equipment was opened. Gossett noted that preventive maintenance required monthly opening of all boxes of electronic equipment. Thus, there were 4x12x3 or 144 times preventive maintenance required opening the SPS-40 boxes plus the separate repair times when Landrum and Kraus recalled Kraus being near one or more of the SPS-40 boxes being opened. Since Kraus' job included monitoring the work of Mr. Stubblefield Kraus had regular and frequent exposure to the asbestos dust from the SPS-40.

The second basis of liability is the acquisition of the former Aerospace/Defense portion of the GE/RCA business. The Court must decide whether it or a jury should resolve the question of whether the agreement between GE and Lockheed's predecessor transferred the liability for the Aerospace Division to Lockheed's predecessor Martin Marietta. GE claims it did so transfer and Lockheed claims it did not accept the liability. The Court will have to resolve this matter to determine who is liable. Plaintiff does not adopt either side's position. He contends that one of them should be liable. As to the GE/RCA products on the ship that argument is that same as the SPS-40, i.e. it was the general rule that all electronic equipment contained resistors and capacitors and the general rule was that these were asbestos containing products. Thus, as the recipient of the Aerospace division and assuming its liabilities Lockheed is liable for all GE/RCA products on the ship. Should defendant be able to prove some resistors and capacitors did not contain asbestos this is still a jury question under *Lamson* supra.

Plaintiff breathed dust from products containing asbestos of Lockheed/GE/RCA on a regular basis. Whether the case is in maritime or Pennsylvania a jury question is made out.

The *Tooey v. A.K. Steel Corp.* 81 A.3d 851 (2013) claim is more complicated. Was that 32nd and Chestnut plant, already closed at the time of the sale of the division of which it has been a part? The Court will have to resolve this in favor of either GE or Lockheed.

Assuming the Court hold that Lockheed is liable for the 32nd and Chestnut plaint it is liable under *Tooey*. The plant had experienced a claim for asbestos in the 1930's. This means that the plant owner knew asbestos was dangerous and in the facility and it was required to warn and protect workers. It failed this duty causing injury. Mr. Covalevski testified at length concerning asbestos in the facility. Lockheed's <u>sole</u> objection to his testimony is that Covalevski left 32nd and Chestnut two years before Kraus arrived. Since both these events were prior to the

enactment of the Occupational Safety and health Act the claims that the asbestos was removed before Kraus arrives are unfounded in their evidence. It is much more likely that asbestos was still there and more likely that Covalevski knows more about present of asbestos a pipe fitter than Kraus.

The motion should be denied.

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COUNTER STATEMENT OF DISPUTED FACTS

1-16. Admitted.

17. Denied. Kraus identified Lockheed as the supplier of the SPS-40 (Exhibit C) and in fact it was the suppler (Exhibits A&B).

18-24. Admitted in part, denied in part. He recalled Lockheed for the SPS-40 (Exhibit C, 210).

25. Denied in that the documents provided by counsel were official government documents.

26-27. Admitted.

28. Denied. Lockheed admits he identified SPS-40 see (Exhibit C, NT 210).

29. Denied. See answer to 28.

30. Denied. The source included official government documents supplied to him by his attorney as well as his recollection of the SPS-40.

31. Admitted except as to SPS-40 which he recalled from memory.

32-33. Admitted in part. He recalled the SPS-40 from memory

34-35. Denied. He recalled the SPS-40, SPS-10 & KW-7 & 37.

36-37. Denied and Admitted. However no one else supplied the SPS-40 and he recalled Lockheed (Exhibit C, NT 210).

38. Denied as to SPS-40 (Exhibit C).

39. Admitted.

40. Admitted as SPS-40, except for the wave guide, was never in the ship.

41. Admitted except the wave guide.

42. Admitted that Lockheed's employee helped the SPS-40 operate.

43. Admitted.

44-48. Admitted in part, denied in part. He only recalled the one occasion. However he was there at other times (Exhibit C, 215).

49. Denied. He identified Lockheed.

50-59. Admitted in part, denied in part. Landrum identified a number of parts by serial number including the SPS-40. Only Lockheed made the SPS-40 for the Cambria. He did identify GE/RCA parts AM/PRC-3, AN PRC-9, AN/SPA-4 & 8, SPS-8 which are GE or RCA parts.

60-66. Denied. Many of the parts are GE/RCA parts. Further identified SPS-40, Lockheed's part. Under maritime law those to be dismissed Allen Bradley, Eimak, Rockbestos can no longer be referenced in the case *McDermott v. Amclyde*, 511 US 202 (1994). Any product not linked to be visible defendant cannot reference in maritime.

67-76. Admitted.

77. Denied in part, admitted in part. They identified the products of Lockheed, GE and RCA. They described the interior parts which were asbestos-containing. They describe Kraus' exposure to the asbestos dust from these parts.

78-85. Admitted. However the deadline for listing materials and exhibits has not yet run. Plaintiff is continuing to look for materials.

86-87. Denied. The patents and articles relied on Mr. Faherty were produced to Lockheed see (Exhibit G).

88-102. Admitted but irrelevant under *Air & Liquid v. DeVries*, 139 Sct. 986 (2019).

103-104. Denied. He was asked to remember hundreds of pages of documents.

105-112. Denied. Faherty and Lockheed have the Navy documents showing SPS-40 was on the ship. Kraus also supplied the documentation of the 1930's case for asbestos in the plant and Covalevski was deposed in his own asbestosis case.

113. Admitted. However, not having objected in the memorandum Lockheed has waived any objection. Further, Evidence Rule 807 allows its admission.

114. Admitted but see answers to 113 supra. Further, it is admittible under F.R. Evid 807.

115. Admitted.

116. Admitted. There is no basis to believe the asbestos was removed between 1968 and 1970.

117. Denied as irrelevant since he's deceased.

118-121. Admitted.

122. Admitted. Denied in that he didn't know.

123-126. Admitted. Plaintiff has attempted to obtain records from Lockheed about this facility but to no avail.

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ORDER

AND NOW, to wit, this ________ day of ___________, 2020, **Lockheed's** motion for summary judgment is hereby **DENIED.**

BY THE COURT:

____
J.

EXHIBIT A

North Plain

In 1953, Stavid Engineering built an 80-acre industrial site that sits Corporation, a predecessor to Lockheed Martin Corp

History

From 1959 to 1989, Lockheed Electronics Company manufactured, tested and assembled electronic components at the site.

- Lockheed closed the operation in 1989, and eventually sold the property. In 1999, the site was redeveloped into a shopping center, the Watchung Square Mall.
- Lockheed, which became Lockheed Martin in 1995 after the merger of Lockheed and Martin Marietta Corporation, assumed responsibility for the environmental cleanup.

Investigation

After closing the plant in 1989, the corporation conducted an initial environmental investigation under the oversight of the New Jersey Department of Environmental Protection (NJDEP).

The investigation identified trichloroethene (TCE), a cleaning solvent that had been used to clean electronic parts, and fuel oil in site soil.

Cleanup

In the early 1990s, the contaminated soil was excavated and disposed of in a licensed off-site landfill.

In some areas of the site, TCE was extracted using a vapor-recovery system to remove contamination from the soil. After the soil cleanup was completed, the Corporation in July 1998 received final approval from the NJDEP, which permitted unrestricted use of the site.

Groundwater

In August 1993, it was determined that groundwater at the site was contaminated with TCE.

Working closely with the NJDEP, the Corporation installed more than 40 monitoring wells to measure the extent of TCE in groundwater. Based on the findings, it was determined that a pump-and-treat system would best clean up the contamination. The system was installed and began operating in July 2003.

Treatment

The treatment system was designed to collect the groundwater and remove the contamination in an aboveground processing facility, and has prevented contamination from entering Crab Brook.

Groundwater contamination has decreased significantly since the system was implemented, and water quality is near or below NJDEP cleanup levels. Groundwater concentrations in the vicinity of the treatment system have been below NJDEP cleanup levels for several years.

As a result, the system was shut down and the treatment equipment was decommissioned and sent to a recycling facility in 2015.

Neighborhood

Lockheed Martin also investigated the possibility that contaminated vapor from the groundwater is entering indoor air in buildings near the site.

The investigation includes the:

- Walmart at Watchung Square Mall; Avalon Watchung apartment complex; Regency Village Condominiums property

- All three sites are closest to the former contamination source. Indoor air quality was measured for the past five years to determine if vapors are entering structures from the ground below.
- In addition, soil vapor samples were collected beneath the foundations at the Walmart, all 16 buildings at Avalon Watchung, and eight buildings at Regency Village to evaluate whether sub-slab soil gas was present.
- Results from each of the sampling events indicated that TCE was not detected at concentrations above the New Jersey Vapor Intrusion Residential Indoor Air Screening Criteria.
- Concentrations of TCE were detected above the New Jersey Soil Gas Screening Level beneath one building on the Avalon Watchung property.
- Therefore, an additional sub-slab soil gas sample will be collected beneath that building at Avalon Watchung; however, no further action is required at Watchung Square Mall or the Regency Condominiums property.

Today

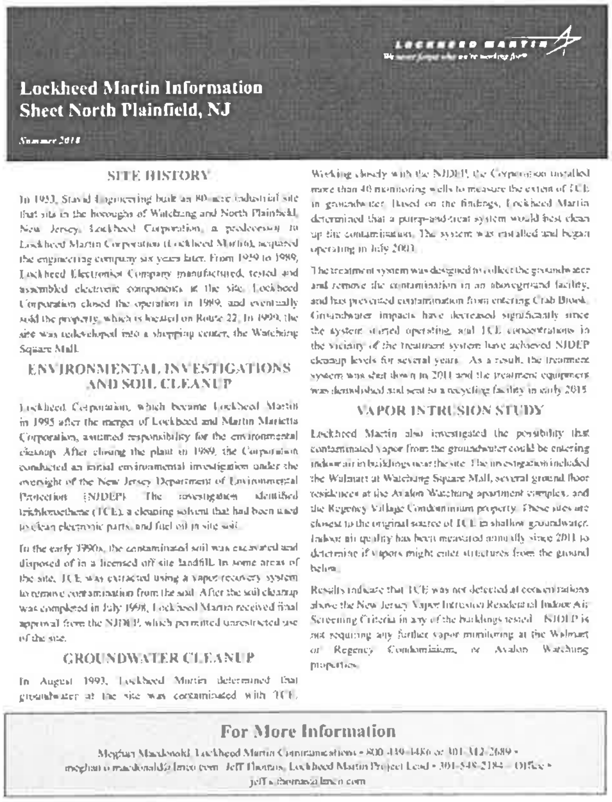
In May 2013, Lockheed Martin submitted a biennial certification to the NJDEP for a groundwater classification exemption area (CEA).

The CEA was established to provide notice to the public that groundwater cleanup levels, while very close, currently are not being met within a defined area.

The public notification was provided in July 2014. In July 2016, a biennial public notification was completed. Also, in that month, a Response Action Outcome, which memorializes the completion of remediation activities, was filed with the NJDEP.

View the North Plainfield, New Jersey Document Achive >

Community Information (/en-us/who-we-are/eesh/remediation/north-plainfield/archive.html) >



Lockheed Martin Information Sheet North Plainfield, NJ

Summer 2018

SITE HISTORY

In 1953, Stavid Engineering built an 80-acre industrial site that sits in the boroughs of Watchung and North Plainfield, New Jersey. Lockheed Corporation, a predecessor to Lockheed Martin Corporation (Lockheed Martin), acquired the engineering company six years later. From 1959 to 1989, Lockheed Electronics Company manufactured, tested and assembled electronic components at the site. Lockheed Corporation closed the operation in 1989, and eventually sold the property, which is located on Route 22. In 1999, the site was redeveloped into a shopping center, the Watchung Square Mall.

ENVIRONMENTAL INVESTIGATIONS AND SOIL CLEANUP

Lockheed Corporation, which became Lockheed Martin in 1995 after the merger of Lockheed and Martin Marietta Corporation, assumed responsibility for the environmental cleanup. After closing the plant in 1989, the Corporation conducted an initial environmental investigation under the oversight of the New Jersey Department of Environmental Protection (NJDEP). The investigation identified trichloroethene (TCE), a cleaning solvent that had been used to clean electronic parts, and fuel oil in site soil.

In the early 1990s, the contaminated soil was excavated and disposed of in a licensed off-site landfill. In some areas of the site, TCE was extracted using a vapor recovery system to remove contamination from the soil. After the soil cleanup was completed in July 1998, Lockheed Martin received final approval from the NJDEP, which permitted unrestricted use of the site.

GROUNDWATER CLEANUP

In August 1993, Lockheed Martin determined that groundwater at the site was contaminated with TCE. Working closely with the NJDEP, the Corporation installed more than 40 monitoring wells to measure the extent of TCE in groundwater. Based on the findings, Lockheed Martin determined that a pump-and-treat system would best clean up the contamination. The system was installed and began operating in July 2003.

The treatment system was designed to collect the groundwater and remove the contamination in an aboveground facility, and has prevented contamination from entering Crab Brook. Groundwater impacts have decreased significantly since the system started operating, and TCE concentrations in the vicinity of the treatment system have achieved NJDEP cleanup levels for several years. As a result, the treatment system was shut down in 2011 and the treatment equipment was demolished and sent to a recycling facility in early 2015.

VAPOR INTRUSION STUDY

Lockheed Martin also investigated the possibility that contaminated vapor from the groundwater could be entering indoor air in buildings near the site. The investigation included the Walmart at Watchung Square Mall, several ground floor residences at the Avalon Watchung apartment complex, and the Regency Village Condominium property. These sites are closest to the original source of TCE in shallow groundwater. Indoor air quality has been measured annually since 2011 to determine if vapors might enter structures from the ground below.

Results indicate that TCE was not detected at concentrations above the New Jersey Vapor Intrusion Residential Indoor Air Screening Criteria in any of the buildings tested. NJDEP is not requiring any further vapor monitoring at the Walmart or Regency Condominium, or Avalon Watchung properties.

For More Information

Meghan Macdonald, Lockheed Martin Communications • 800-449-4486 or 301-312-2689 • meghan.o.macdonald@lmco.com Jeff Thomas, Lockheed Martin Project Lead • 301-548-2184 – Office • jeff.s.thomas@lmco.com

Information Sheet Summer 2018 (/content/dam/lockheed-martin/eo/documents/remediation/n-plainfield-nj/factsheet-july2018.pdf)

Timeline

1953 - Stavid Engineering built an 80-acre industrial site that sits in the boroughs of Watchung and North Plainfield, N.J.

1959 - Lockheed Corporation, a predecessor to Lockheed Martin Corporation, acquired the engineering company

1959 - 1989 - Lockheed Electronics Company manufactured, tested and assembled electronic components at the site

1990's - The contaminated soil was excavated and disposed of in a licensed off-site landfill

August 1993 - It was determined that groundwater at the site was contaminated with TCE.

July 1998 - Lockheed received final approval from the NJDEP, which permitted unrestricted use of the site

1999 - Lockheed sold the property and the site was redeveloped

July 2003 - The system was installed and began operating.

May 2013 - Lockheed Martin submitted a biennial certification to the NJDEP for a Groundwater Classification Exemption Area (CEA)

July 2014 - The public notification was provided

2015 - The system was shut down

July 2016 - A biennial public notification was completed. A Response Action Outcome, which memorializes the completion of remediation activities, was filed with the NJDEP

Glossary (/en-us/who-we-are/eesh/remediation/glossary.html): View a List of Terms Commonly Used in Relation to General Environmental Remediation Efforts

Acronyms (/en-us/who-we-are/eesh/remediation/acronyms.html): View a List of Nicknames Commonly Used in Relation to General Environmental Remediation Efforts

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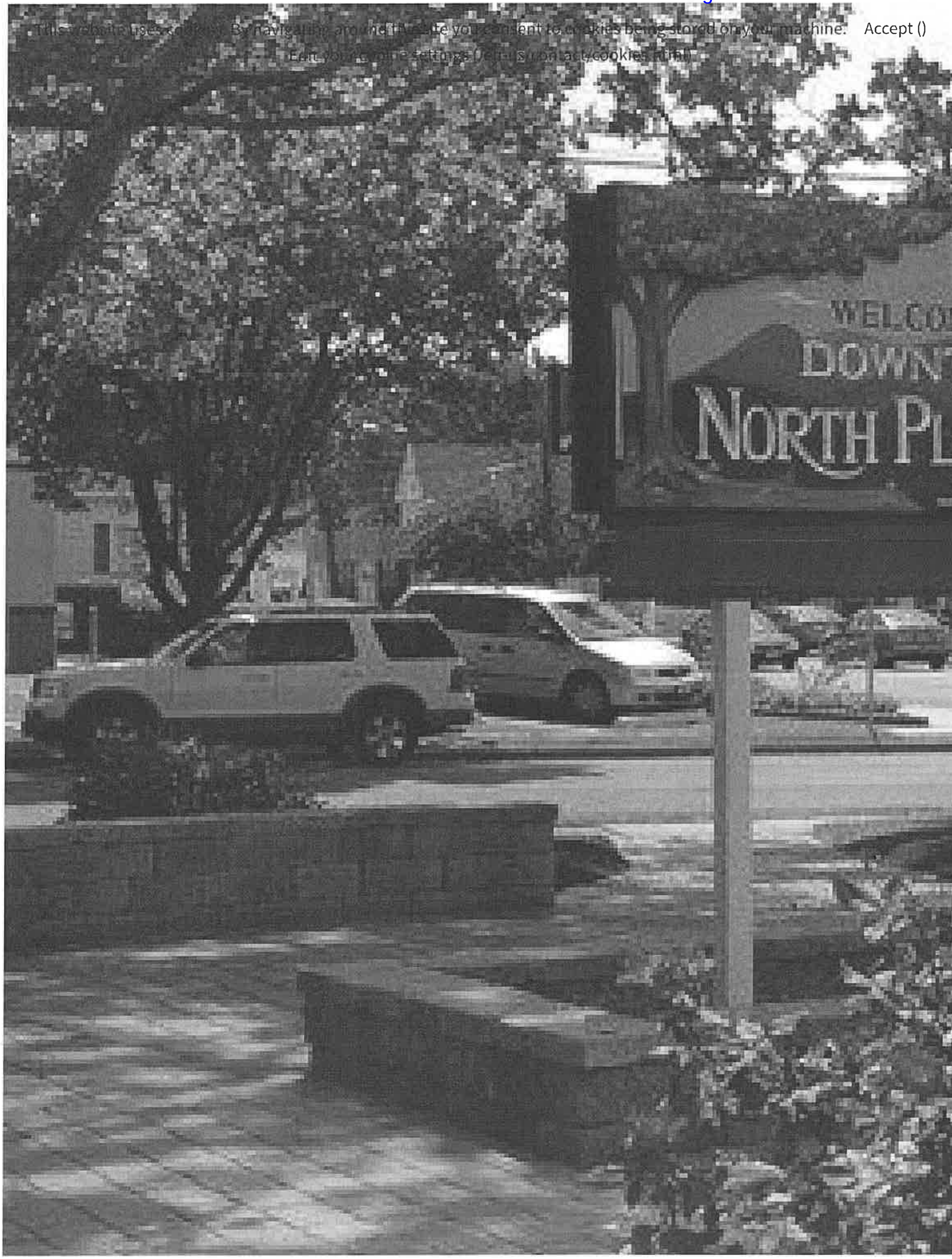

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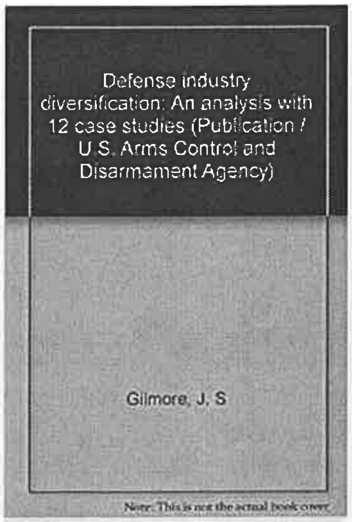

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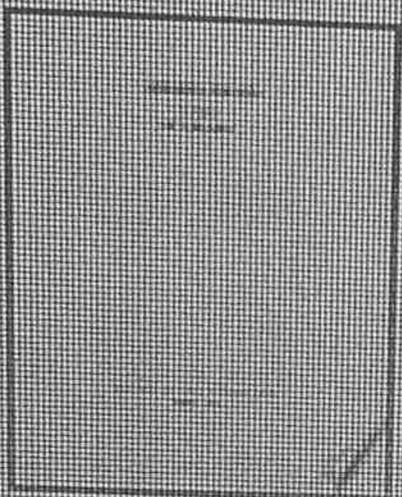

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Defense Industry Diversification: An Analysis with 12 Case Studies

By United States. Arms Control and Disarmament Agency

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In addition, several other possible products, which would have represented diversifi-
:ion for Lockheed, were evaluated during the Post-War period. For example, in 1945, :kheed got into the material handling equipment industry through the acquisition of rquipment Company and into industrial equipment with the acquisition of Aerol, Inc. ese acquisitions were sold in 1951 when management attention turned to Korean War :quirements. Lockheed established an Architectural Products Division in 1960 to manufac- ire aluminum sidewall for large buildings. The Division carried out some research and onstructed prototypes of prefabricated homes. In 1965, Lockheed and a Puerto Rican uilder joined in a public demonstration of the former's "Panelock" prefabricated housing oncept.

Right after World War II, Lockheed also gave serious consideration to the manufacturing of automobiles and private, light aircraft. Both of these ideas were abandoned.

In 1958, Lockheed created its own Lockheed Electronics and Avionics Division to help launch the company into the manufacture and marketing of electronics components, equipment, systems, and advanced instrumentation. The announced purpose of the formation of the new Division was to take advantage of the new technological revolution by going into solid state electrical devices which offered advantages in increased speed, reliability, sensitivity, and versatility. A year later, in May 1959, Lockheed announced an agreement to acquire Stavid Engineering, a New Jersey electronics firm. Stavid and the newly-formed Lockheed Electronics and Avionics Division were consolidated into what was called the Lockheed Electronics Company, headquartered in Plainfield, New Jersey.

In 1959 and 1960, Lockheed made its most aggressive diversification moves. The 1959 Annual Report listed 16 steps taken during 1959 and early 1960 aimed at broadening markets and product lines, and building "across the board competence." Included in the list were the April 1959 acquisition of Puget Sound Bridge and Dredging Company, a Seattle shipbuilding, ship repair, and heavy construction firm (see Appendix B for more detail), and the purchase of a 50 percent interest in Grand Central Rocket Company, then the nation's fourth largest producer of rocket motors and solid-fueled rockets.

Announcing the diversification moves in 1959 and early 1960, Robert Gross explained that the company's diversification policy was, "building strength through acquisitions, developing competence from within, stressing imaginative thinking, exploring ways of satisfying consumer needs."

He acknowledged that Lockheed's moves had been "rapid and bold" in some cases, but were carefully patterned to fill in a complete spectrum. He continued:

We would be the first to admit that merely buying a company or opening

Lockheed Corporation

The **Lockheed Corporation** was an American aerospace company. Lockheed was founded in 1926 and later merged with Martin Marietta to form Lockheed Martin in 1995. The founder, Allan Lockheed, had earlier founded the similarly named but otherwise unrelated Loughead Aircraft Manufacturing Company, which was operational from 1912 through 1920.

Lockheed Corporation

Former type	privately held company
Industry	Aerospace
Fate	Merged with Martin Marietta
Predecessor	Alco Hydro-Aeroplane Company
Successor	Lockheed Martin
Founded	1926
Founder	Allan Lockheed, Malcolm Loughead
Defunct	1995
Headquarters	Calabasas, California[1]
Products	Aircraft

Contents

History

Origins

Allan Loughead and his brother Malcolm Loughead had operated an earlier aircraft company, Loughead Aircraft Manufacturing Company, which was operational from 1912 to 1920.[2] The company built and operated aircraft for paying passengers on sightseeing tours in California and had developed a prototype for the civil market, but folded in 1920 due to the flood of surplus aircraft deflating the market after World War I. Allan went into the real estate market while Malcolm had meanwhile formed a successful company marketing brake systems for automobiles.[3]

In 1926, Allan Lockheed, John Northrop, Kenneth Kay and Fred Keeler secured funding to form the **Lockheed Aircraft Company** in Hollywood (the spelling was changed phonetically to prevent mispronunciation).[4] This new company utilized some of the same technology originally developed for the Model S-1 to design the Vega Model. In March 1928, the company relocated to Burbank, California, and by year's end reported sales exceeding one million dollars. From 1926 to 1928 the company produced over 80 aircraft and employed more than 300 workers who by April 1929 were building five aircraft per week. In July 1929, majority shareholder Fred Keeler sold 87% of the Lockheed Aircraft Company to Detroit Aircraft Corporation. In August 1929, Allan Loughead resigned.

The Great Depression ruined the aircraft market, and Detroit Aircraft went bankrupt. A group of investors headed by brothers Robert and Courtland Gross, and Walter Varney, bought the company out of receivership in 1932. The syndicate bought the company for a mere $40,000 ($660,000 in 2011). Ironically, Allan Loughead himself had planned to bid for his own company, but had raised only $50,000 ($824,000), which he felt was too small a sum for a serious bid.[5]

In 1934, Robert E. Gross was named chairman of the new company, the Lockheed Aircraft Corporation, which was headquartered at what is now the airport in Burbank, California. His brother Courtlandt S. Gross was a co-founder and executive, succeeding Robert as chairman following his death in 1961. The company was named the Lockheed Corporation in 1977.

The first successful construction that was built in any number (141 aircraft) was the Vega first built in 1927, best known for its several first- and record-setting flights by, among others, Amelia Earhart, Wiley Post, and George Hubert Wilkins. In the 1930s, Lockheed spent $139,400 ($2.29 million) to develop the Model 10 Electra, a small twin-engined transport. The company sold 40 in the first year of production. Amelia Earhart and her navigator, Fred Noonan, flew it in their failed attempt to circumnavigate the world in 1937. Subsequent designs, the Lockheed Model 12 Electra Junior and the Lockheed Model 14 Super Electra expanded their market.

Prewar production

The Lockheed Model 14 formed the basis for the Hudson bomber, which was supplied to both the British Royal Air Force and the United States military before and during World War II.[6][7] Its primary role was submarine hunting. The Model 14 Super Electra were sold abroad, and more than 100 were license-built in Japan for use by the Imperial Japanese Army.[8]

Production during World War II

P-38J Lightning *Yippee*

At the beginning of World War II, Lockheed – under the guidance of Clarence (Kelly) Johnson, who is considered one of the best-known American aircraft designers – answered a specification for an interceptor by submitting the P-38 Lightning fighter aircraft, a twin-engined, twin-boom design. The P-38 was the only American fighter aircraft in production throughout American involvement in the war, from Pearl Harbor to Victory over Japan Day.[9] It filled ground-attack, air-to-air, and even strategic bombing roles in all theaters of the war in which the United States operated. The P-38 was responsible for shooting down more Japanese aircraft than any other U.S. Army Air Forces type during the war; it is particularly famous for being the aircraft type that shot down Japanese Admiral Isoroku Yamamoto's airplane.[10][11]

P-38 Lightning assembly line at the Lockheed plant, Burbank, California in World War II. In June 1943, this assembly line was reconfigured into a mechanized line, which more than doubled the rate of production. The transition to the new system was accomplished in only eight days. During this time production never stopped. It was continued outdoors.[12]

The Lockheed Vega factory was located next to Burbank's Union Airport which it had purchased in 1940. During the war, the entire area was camouflaged to fool enemy aerial reconnaissance. The factory was hidden beneath a huge burlap tarpaulin painted to depict a peaceful semi-rural neighborhood, replete with rubber automobiles.[13][14] Hundreds of fake trees, shrubs, buildings, and even fire hydrants were positioned to give a three-dimensional appearance. The trees and shrubs were created from chicken wire treated with an adhesive and covered with feathers to provide a leafy texture.[10][15]

Lockheed ranked tenth among United States corporations in the value of wartime production contracts.[16] All told, Lockheed and its subsidiary Vega produced 19,278 aircraft during World War II, representing six percent of war production, including 2,600 Venturas, 2,750 Boeing B-17 Flying Fortress bombers (built under license from Boeing), 2,900 Hudson bombers, and 9,000 Lightnings.[17]

Postwar production

During World War II, Lockheed, in cooperation with Trans-World Airlines (TWA), had developed the L-049 Constellation, a radical new airliner capable of flying 43 passengers between New York and London at a speed of 300 mph (480 km/h) in 13 hours.

Once the Constellation (nicknamed *Connie*) went into production, the military received the first production models; after the war, the airlines received their original orders, giving Lockheed more than a year's head-start over other aircraft manufacturers in what was easily foreseen as the post-war modernization of civilian air travel. The Constellations' performance set new standards which transformed the civilian transportation market. Its signature tri-tail was the result of many initial

customers not having hangars tall enough for a conventional tail. Lockheed produced a larger transport, the double-decked R6V Constitution, which was intended to make the Constellation obsolete. However, the design proved underpowered.

A Lockheed L-049 Constellation sporting the livery of Trans World Airlines at the Pima Air & Space Museum.

Skunk Works

In 1943, Lockheed began, in secrecy, development of a new jet fighter at its Burbank facility. This fighter, the Lockheed P-80 Shooting Star, became the first American jet fighter to score a kill. It also recorded the first jet-to-jet aerial kill, downing a Mikoyan-Gurevich MiG-15 in Korea, although by this time the F-80 (as it was redesignated in June 1948) was already considered obsolete.[18]

The Lockheed U-2, which first flew in 1955, provided intelligence on Soviet bloc countries.

Starting with the P-80, Lockheed's secret development work was conducted by its Advanced Development Division, more commonly known as the Skunk works. The name was taken from Al Capp's comic strip Li'l Abner. This organization has become famous and spawned many successful Lockheed designs, including the U-2 (late 1950s), SR-71 Blackbird (1962) and F-117 Nighthawk stealth fighter (1978). The Skunk Works often created high-quality designs in a short time and sometimes with limited resources.

The Lockheed SR-71 Blackbird

Projects during the Cold War

In 1954, the Lockheed C-130 Hercules, a durable four-engined transport, flew for the first time. This type remains in production today. In 1956, Lockheed received a contract for the development of the Polaris Submarine Launched Ballistic Missile (SLBM); it would be followed by the Poseidon and Trident nuclear missiles. Lockheed developed the F-104 Starfighter in the late 1950s, the world's first Mach 2 fighter jet. In the early 1960s, the company introduced the C-141 Starlifter four-engine jet transport.

During the 1960s, Lockheed began development for two large aircraft: the C-5 Galaxy military transport and the L-1011 TriStar wide-body civil airliner. Both projects encountered delays and cost overruns. The C-5 was built to vague initial requirements and suffered from structural weaknesses, which Lockheed was forced to correct at its own expense. The TriStar competed for the same market as the McDonnell Douglas DC-10; delays in Rolls-Royce engine development caused the TriStar to fall behind the DC-10. The C-5 and L-1011 projects, the canceled U.S. Army AH-56 Cheyenne helicopter program, and embroiled shipbuilding contracts caused Lockheed to lose large sums of money during the 1970s.

Drowning in debt, in 1971 Lockheed (then the largest US defense contractor) asked the US government for a loan guarantee, to avoid insolvency. The measure was hotly debated in the US Senate. The chief antagonist was Senator William Proxmire (D-Wis), the nemesis of Lockheed and its chairman, Daniel J. Haughton. Following a fierce debate, Vice President Spiro T. Agnew cast a tie-breaking vote in favor of the measure (August 1971). Lockheed finished paying off the $1.4 billion loan in 1977, along with about $112.22 million in loan guarantee fees.[19]

The Lockheed C-130 Hercules serves as the primary tactical transport for many military forces worldwide.

Bribery scandals

The Lockheed bribery scandals were a series of illegal bribes and contributions made by Lockheed officials from the late 1950s to the 1970s. In late 1975 and early 1976, a subcommittee of the U.S. Senate led by Senator Frank Church concluded that members of the Lockheed board had paid members of friendly governments to guarantee contracts for military aircraft.[20] In 1976, it was publicly revealed that Lockheed had paid $22 million in bribes to foreign officials[21] in the process of negotiating the sale of aircraft including the F-104 Starfighter, the so-called Deal of the Century.[22][23]

The scandal caused considerable political controversy in West Germany, the Netherlands, Italy, and Japan. In the US, the scandal led to passage of the Foreign Corrupt Practices Act, and nearly led to the ailing corporation's downfall (it was already struggling due to the poor sales of the L-1011 airliner). Haughton resigned his post as chairman.[24]

Attempted leveraged buyout

In the late 1980s, leveraged buyout specialist Harold Simmons conducted a widely publicized but unsuccessful takeover attempt on the Lockheed Corporation, having gradually acquired almost 20 percent of its stock. Lockheed was attractive to Simmons because one of its primary investors was the California Public Employees' Retirement System (CalPERS), the pension fund of the state of California. At the time, the *New York Times* said, "Much of Mr. Simmons's interest in Lockheed is believed to stem from its pension plan, which is over funded by more than $1.4 billion. Analysts said he might want to liquidate the plan and pay out the excess funds to shareholders, including himself." Citing the mismanagement by its chairman, Daniel M. Tellep, Simmons stated a wish to replace its board with a slate of his own choosing, since he was the largest investor. His board nominations included former Texas Senator John Tower, the onetime chairman of the Armed Services Committee, and Admiral Elmo Zumwalt Jr., a former Chief of Naval Operations.[25][26] Simmons had first begun accumulating Lockheed stock in early 1989 when deep Pentagon cuts to the defense budget had driven down prices of military contractor stocks, and analysts had not believed he would attempt the takeover since he was also at the time pursuing control of Georgia Gulf.[27]

Timeline

- 1912: The Alco Hydro-Aeroplane Company established.
- 1916: Company renamed Loughead Aircraft Manufacturing Company.

- 1926: Lockheed Aircraft Company formed.
- 1929: Lockheed becomes a division of Detroit Aircraft.
- 1932: Robert and Courtland Gross take control of company after the bankruptcy of Detroit Aircraft. Company renamed Lockheed Aircraft Corporation, reflecting the company's reorganization under a board of directors.
- 1943: Lockheed's Skunk Works founded in Burbank, California.
- 1954: First flight of the Lockheed C-130 Hercules.
- 1954: Maiden flight of the Lockheed U-2.
- 1961: Grand Central Rocket Company acquired as Lockheed Propulsion Company.
- 1962: First flight of the A-12 Blackbird.
- 1964: First flight of the Lockheed SR-71 Blackbird.
- 1970 First flight of the L-1011 TriStar.
- 1976: The Lockheed bribery scandals.
- 1977: Company renamed Lockheed Corporation, to reflect non-aviation activities of the company.
- 1978: The company's Hollywood-Burbank Airport is sold to its nearby cities and becomes Burbank-Glendale-Pasadena Airport (later renamed Bob Hope Airport in 2003).[28]
- 1981: First flight of the F-117 Nighthawk.
- 1985: Acquires Metier Management Systems.
- 1986: Acquires Sanders Associates electronics of Nashua, New Hampshire.
- 1991: Lockheed, General Dynamics and Boeing begin development of the F-22 Raptor.
- 1992: All aerospace related activities end at the Burbank facility.
- 1993: Acquires General Dynamics' Fort Worth aircraft division, builder of the F-16 Fighting Falcon.
- 1995: Lockheed Corporation merges with Martin Marietta to form Lockheed Martin.

Divisions

Lockheed's operations were divided between several groups and divisions, many of which continue to operate within Lockheed[29]

Aeronautical Systems group

- Lockheed-California Company (CALAC), Burbank, California.
- Lockheed-Georgia Company (GELAC), Marietta, Georgia.
- Lockheed Advanced Aeronautics Company, Saugus, California.
- Lockheed Aircraft Service Company (LAS), Ontario, California.
- Lockheed Air Terminal, Inc. (LAT), Burbank, California, now Bob Hope Airport and owned by the Burbank-Glendale-Pasadena Airport Authority.

Missiles, Space, and Electronics Systems Group

- Lockheed Missiles & Space Company, Inc., Sunnyvale, California.
- Lockheed Propulsion Company, Redlands, California.
- Lockheed Space Operations Company, Titusville, Florida.
- Lockheed Engineering and Management Services Company, Inc., Houston, Texas.
- Lockheed Electronics Company, Inc., Plainfield, New Jersey.

Marine Systems group

- Lockheed Shipbuilding Company, Seattle, Washington.
- Lockport Marine Company, Portland, Oregon.
- Advanced Marine Systems, Santa Clara, California.

Information Systems group

- Datacom Systems Corporation, Teaneck, New Jersey.
- CADAM Inc., Burbank, California.
- Lockheed Data Plan, Inc., Los Gatos, California.
- DIALOG Information Services, Inc, Palo Alto, California.
- Metier Management Systems, London, England.
- Integrated Systems and Solutions, Gaithersburg, Maryland.

Product list

A partial listing of aircraft and other vehicles produced by Lockheed.

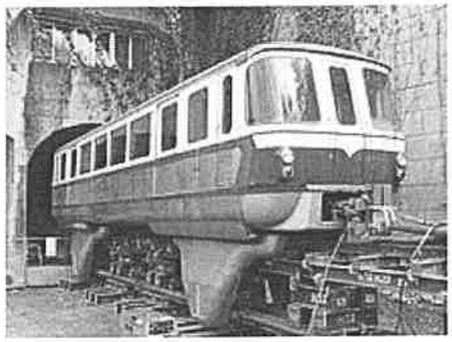
Lockheed's most advanced airliner, the L-1011 Tristar

Odakyu Type 500 monorail, 1990. (1966–2001)

Airliners and civil transports

- Lockheed Vega
- Lockheed Model 10 Electra
- Lockheed Model 12 Electra Junior
- Lockheed Model 14 Super Electra
- Lockheed Model 18 Lodestar
- Lockheed Constellation, airliner
- Lockheed L-049 Constellation, first model of the Lockheed Constellation
- Lockheed L-649 Constellation, improved Lockheed Constellation
- Lockheed L-749 Constellation, further improved Lockheed Constellation
- Lockheed L-1049 Super Constellation, largest produced model of the Lockheed Constellation
- Lockheed L-1649 Starliner, last model of the Lockheed Constellation
- Lockheed Saturn
- Lockheed L-188 Electra
- Lockheed JetStar, business jet
- L-1011 TriStar, wide-body airliner
- Odakyu Type 500 monorail for Mukōgaoka-Yūen Monorail (as **Nihon-Lockheed Monorail**, with Kawasaki Heavy Industries), in service from 1966 to 2001
- Himeji Monorail Type 100/200 (as **Nihon-Lockheed Monorail**, with Kawasaki Heavy Industries), in service from 1966 to 1974

Military transports



Preserved Himeji Monorail coach 202, November 2009. (1966–1974)

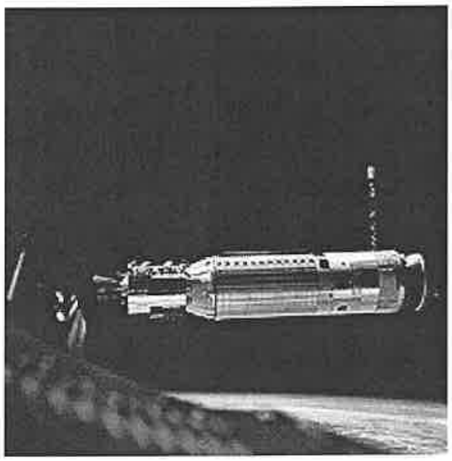
- Lockheed C-69/Lockheed C-121 Constellation, military transport versions of the Constellation
  - YC-121F Constellation, experimental turboprop version
- Lockheed R6V Constitution, large transport aircraft
- Lockheed C-130 Hercules, medium combat transport (AC-130 gunship) (other variants)
- Lockheed C-141 Starlifter, long-range jet transport
- Lockheed C-5 Galaxy, heavy transport
- Flatbed, military transport project, canceled

Fighters

Lockheed Trident II missile, introduced in 1990.

- Lockheed P-38 Lightning, twin-engine propeller fighter
- Lockheed P-80 Shooting Star, the United States Air Force's first operational jet fighter
- Lockheed T-33 Shooting Star, trainer jet
- Lockheed F-94 Starfire, all-weather fighter'
- Lockheed F-104 Starfighter, interceptor and later a multi-mission fighter, the 'missile with a man in it'
- Lockheed F-117 Nighthawk, stealth fighter attack aircraft
- General Dynamics F-16 Fighting Falcon, multirole fighter (Originally General Dynamics)
- Lockheed YF-22, air superiority stealth fighter

Patrol and reconnaissance



Lockheed's advanced upper rocket stage, the Agena.

- Lockheed Hudson, maritime patrol/bomber
- PV-1 Ventura and PV-2 Harpoon, Maritime patrol/bomber
- PO-1W/WV-1 Constellation, AWACS version of the Constellation
- EC-121/WV-2 Warning Star, AWACS version of the Super Constellation
- Lockheed P-2 Neptune, maritime patrol
- Lockheed P-3 Orion, ASW patrol
- Lockheed U-2/TR-1, reconnaissance
- Lockheed SR-71 Blackbird, reconnaissance (A-12) (M-21) (YF-12)
- Lockheed S-3 Viking, patrol/attack
- YO-3A Quiet Star

Helicopters

- Lockheed CL-475, rigid-rotor helicopter
- XH-51A/B (Lockheed CL-595/Model 286), compound helicopter testbed

- Lockheed AH-56 Cheyenne, prototype attack compound helicopter

Missiles

- UGM-27 Polaris
- UGM-73 Poseidon
- UGM-89 Perseus
- Trident
  - UGM-96 Trident I
  - UGM-133 Trident II
- High Virgo

Space technology

- Lockheed X-7
- Lockheed X-17
- Lockheed L-301 (aka X-24C)
- Lockheed Star Clipper
- Corona
- RM-81 Agena
  - Agena target vehicle
- Apollo Launch Escape System
- Hubble Space Telescope

Sea vessels

- *Sea Shadow*

See also

- Vega Aircraft Corporation
- Lloyd Stearman
- California during World War II

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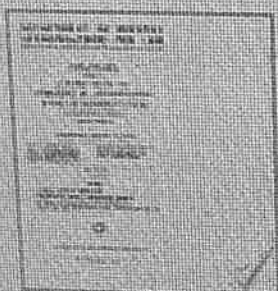

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My History

NS AND ELECTRONIC EQUIPMENT—PROBABLE SOLE-SOURCE PROCUREMENT, FISCAL YEAR 1969

Manufacturer	Reason	Date comp procure anticip
Radio Electronics	Radio Electronics is the only producer, and suitable technical data is not available for a competitive award.	No future ment pla
Collins Radio (4)	For ancillary equipment which will be or backfits and SEA requirements.	Fiscal year
General Electric	GE as designer and producer of AN/SPS 30 radar has requisite technical background and system to test improvements.	Not known
	Lockheed is development contractor of the AN/SPS 40 and there is no model available for Government-furnished equipment (GFE).	Do.[1]
Hughes Aircraft Co	Hughes is the only designer and producer of this radar and has technical knowledge of equipment for producing modification pits.	Do.[1]
do		
Scope, Inc	Scope, Inc. is the only producer with the technical knowledge necessary to meet a delivery schedule based on urgent military requirements.	Do.[3]
Sylvania	Sylvania is the developer of the R. & D. model and the sole producer	Fiscal year
RCA	RCA is the only producer with the technical knowledge necessary to meet a delivery schedule based on urgent military requirements.	Not known.
do		
Cubic, Inc	Cubic, Inc., is the only producer with the technical knowledge necessary to meet a delivery schedule based on urgent military requirements.	Do.[3]
Sylvania	Sylvania is the only producer with the technical knowledge necessary to meet a delivery schedule based on urgent military requirements.	Do.[3]
Bell Aero Systems	Bell is the only previous producer of the AN/SPN 10	
Bell Aero Systems, Univac	Lack of technical data for competitive award	Do.[1]
EDO Corp	To make support equipment compatible with prime equipment	Do.[1]
ITT Gilfillan	do	Do.[1]
Hughes Aircraft Co	do	
do	do	Do.[1]
Nortronics	Lack of technical data for competitive award	Do.[1]
RCA	RCA is the only producer with the technical knowledge necessary to meet a delivery schedule based on urgent military requirements.	Do.[1]
Bell Aero System	Bell Aero System is the only producer with the technical knowledge necessary to meet a delivery schedule based on urgent military requirements.	Fiscal year
do	do	Do.[1]
B. F. Goodrich	Delivery can only be met by the 1 development contractor	Do.[3]
Sangamo	Sangamo is the development contractor and is therefore best technically qualified to meet required delivery schedule.	Do.[1]
Sperry	There is no 2d source with sufficient knowledge to produce [illegible] meet delivery schedules	Fiscal year
Edo Corp	There is [illegible]	Not known
do		

EXHIBIT C

IN THE COURT OF COMMON PLEAS

PHILADELPHIA COUNTY, PENNSYLVANIA

\- - -

ROBERT J. KRAUS and MARGARET M. KRAUS, h/w	:	APRIL TERM, 2018
v.	:	
ALCATEL-LUCENT, et al.	:	NO. 3448

\- - -

November 27, 2018

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Videotape trial of ROBERT KRAUS, taken pursuant to notice, was held at the offices of Magna Legal Services, 1635 Market Street, Philadelphia, Pennsylvania, commencing at 9:40 a.m., on the above date, before Melissa Broderick, a Professional Court Reporter and Notary Public for the Commonwealth of Pennsylvania.

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speculation, no foundation,
overbroad, time, place.
THE WITNESS: That one I can
answer because of work I did at --
for example, I was an engineer at
General Electric.
BY MR. PAUL:
Q. Right.
A. And I've also got chemo
brain.
Q. Well, we'll get to that.
We'll get to that in a bit.
A. But I'm saying I can't
remember things that I heard five minutes
ago. Sometimes I can't remember people's
names.
Q. All right.
A. So what was the question,
again?
Q. My question was, if you
know, if there's a difference between
this Navy equipment you were --
A. Oh, okay. Right.
Q. -- and civilian equipment,

Page 43

if you know?
DEFENSE COUNSEL: Same
objection.
THE WITNESS: Yeah, because
-- well, because I've had
experience both at Control Data,
at GE.
We were working on -- when I
worked at Control Data, I was
designing changes/modifications to
the flyover target card computer
system. It was a military system.
When I was working at GE, I
had two different jobs. And
first, I worked on equipment for
controlling satellites in orbit.
And the other one was, is I worked
for the MIRV program.
BY MR. PAUL:
Q. What is that?
A. You've heard of multiple
independently targeted reentry vehicles,
MIRVs.
Q. Okay.

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A. Those are missiles that go
up, and they carry a lot of smaller
missiles. And each one of those serve as
separate missiles, is independently
targeted.
So you could send up what
looks like one missile, but it has
several missiles inside. And you can
target each one of those independently,
so that they would go to their particular
city or wherever they were going to go.
And the answer to your
question, there were -- all of the
military equipment required that the
components are MIL-SPEC. That means they
meet military specification, which is a
more rigid specification than you would
have, for example, in your home TV or any
of your other equipment, your cell phones
today, or whatever.
And that was equipment that
was tested to, like, whatever -- the
equipment -- where it was going to be
used would experience high temperatures.

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High temperature was death to a power
tube -- I mean, to a transistor.
A transistor is -- when
they're operated at a high power, they
actually get very hot. But that was one
of the limits as to how hot you could
make them and not destroy them. And so
the Navy always wanted ones that it
tested to the very highest power that it
could get.
Q. When you say tested to the
highest power, you mean ability --
A. Highest temperature, power,
whatever. They're kind of synonymous.
If you run a lot of power or energy
through it, then it gets very hot.
DEFENSE COUNSEL: Motion to
strike nonresponsive portions and
based on speculation.
BY MR. PAUL:
Q. Following up counsel's
objection, he says you don't know what
you're talking about. So could you
respond to that, and explain to him

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candidate school. If they accept you, then you go to Newport, Rhode Island, and you basically study Navy. You study leadership. You study everything you ever wanted to know about the military, what is it is and what your status in the organization and so forth. They teach you navigation and a lot of the things associated with sailing.

Q. What did -- what was your job duties in the Navy?

A. So after I graduated from OCS, I accepted the commission as an ensign. I'd actually been an enlisted man. When you go to OCS, if you fail out, you would end up in the enlisted Navy.

So I have two honorably discharges, one from there, one from officer candidate school, and the second from the Navy.

But my assignment, I was -- the day after I was commissioned, which was in June. I don't remember the exact

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date, but it's in my data here -- I was ordered to report to a ship, the USS Cambria.

And it was actually a two-step process. First, I was supposed to report to training school in, I think it was, Little Creek, Virginia. Because the Cambria is an amphibious Navy -- it's one of the ships that carries the Marines -- we traveled in a squadron, and so I needed to know more about that. So they sent me to school for that.

The ship was in the Mediterranean at that time. It came back to the states. And so as the -- I was appointed the electro -- electronics material -- EMO. I think it's electronic material officer was the title they gave me. It had specific responsibilities.

Q. What were those?

A. And I was responsible for every piece of electronic equipment on that ship working constantly and regularly.

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Q. Can you describe types of -- when you say electronics equipment, what are you talking about?

A. The two biggest things we had were two radars. We had an air search radar and surface search radar. The air search radar would see out about 300 miles. And that's what it did. It looked for aircraft. Also, looked for missals --

Q. Okay.

A. -- that were aimed at the ship.

We also had a piece of equipment, electronic countermeasures equipment, which was used to try to confuse any missals, if they were sent at our ship. So that's the air search radar.

We had a surface search radar, which is just as important. In my opinion, these were about two of the most important pieces of equipment on the ship, because without them, you can't

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see. You can't see enemies. You can't see anything you might run into. We would typically sail darkened ship when we were in a squadron.

The brunt of the equipment was the radios. We had radio, transmitters, and receivers. Last count, we had almost -- that I did from a list I prepared -- and you've all seen that, I think -- we had over 300 -- after the ship had an overhaul, it was shortly after I went aboard the ship -- we had over 300 pieces of electronic equipment on the ship.

Q. What did you have to do with the electronic equipment?

A. It was considered a managerial job, or you could also consider it -- I mean, it was largely administrative. What I did is I actually worked -- I worked out of the ET shop.

Q. What is that?

A. Which is a shop on board the ship that was specifically for

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maintaining and repairing all the electronic equipment.

And so I was responsible for making sure that all of the regulations -- and the Navy has a lot of regulations on when and where and what happens to every piece of that equipment. As a matter of fact, at one point in time, I had to sign for every piece of equipment, okay.

And so there were periodic maintenances that were required for different -- it varied depending on the piece of equipment. And we had a lot of other types of equipment, too, besides radios, but I won't go into that for this second.

But each piece of equipment had its own special card, okay. And it kept track of -- and other documents that went along with that -- kept track every time that one of those pieces of equipment came in, when it was maintained, when it was due for another

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regular maintenance.

And we made changes to the equipment periodically, if it was improved or updated, and we would do some type of an alteration. A lot of these things were called ship alts.

And so I was just there for that purpose, to make sure that -- that position was to monitor, make sure that all of these things were done. If there was a particular issue with a particular piece of equipment, I had to know about it. I had to do something about it.

We've had situations where -- we had 24 landing craft on board that ship to land 1200 Marines that we carried. And the radios we were using on those boats, when we put the Marines in the water on our boats, they'd typically go out, and they would circle until they were all in this formation. They had to be able to communicate with the ship. They had to be able to communicate with each other. And they were still using

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World War II radios that they were constantly breaking down.

So that was one of the things we had to find a resolution for, that is, me and -- I had the chief petty officer. That's equivalent to a sergeant in the Army, if you're not used to Navy lingo. And, eventually, to a master chief petty officer, as my ET crew grew from 12 to some higher number, 15 or so.

So it was an administrative job that doesn't sound very sexy, but it had an awful lot of problems that we had to work out.

Q. Well, you've mentioned -- used a couple of terms, and I wanted to ask you about those. You used the term "periodic maintenance" a minute ago.

A. Uh-huh.

Q. What is periodic maintenance? What happens in a periodic maintenance?

A. Typical piece of equipment -- most of the equipment on -- the

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electronic equipment was rack mounted.

Q. What does that mean?

A. And that means there were literally these racks -- these structures that are like a framework. And there -- a lot of them are in the radio -- I say radio rooms. We had about -- I think, up to five radio rooms on the ship, because we were the flagship, so we carried the flag officer. He had all of his own -- duplicated everything we had except for the radars.

So maintenance, we would bring the piece of equipment in. We'd take it out of the rack. So now, where you could originally see the front panel, but you couldn't see the rest of the particular electronic equipment, when you took it out, you could see all of that because it was cabinets that enclosed it were still sitting back in the radio room.

We'd bring it down to the ET shop. And the first thing they would do

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is they would clean it, okay.
Q. When they cleaned it, what did they do?
A. There were two different ways they typically cleaned it. One, they used a vacuum, and would vacuum out every part of the radio they could get to.
And the second was -- well, they used some chemicals periodically, if there was corrosion, or if there were problems with any equipment making proper contact with switches, for example, that were in there. We would -- so that was it.
DEFENSE COUNSEL: Belated objection. Overbroad as to equipment and time.
BY MR. PAUL:
Q. Why did the radios and these other pieces of equipment have to be vacuumed?
A. Easiest way to say it is they got dirty. It's like anything else

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in your house, if you let it sit there for a long time -- and they were -- and they were hot, typically.
DEFENSE COUNSEL: Same objection.
THE WITNESS: Most of the radios had electronic tubes. Some had electronic tubes and transistors, a combination. And if you've ever looked in anything -- any piece of equipment, like your TV, for example, at home, it's going to get very dusty inside.
And so that's basically what they were doing, vacuuming whatever dust was in there.
BY MR. PAUL:
Q. What do you recall -- do you recall any components of these radios?
DEFENSE COUNSEL: Objection. Overbroad as to equipment and to time.
MR. PAUL: You can answer

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the question.
THE WITNESS: Could you repeat the question?
MR. PAUL: Yeah. Have it read back.
- - -
(The court reporter read the pertinent part of the record.)
- - -
DEFENSE COUNSEL: Also compound.
THE WITNESS: I'm not sure what you mean by components, but, for example, there were circuit boards.
BY MR. PAUL:
Q. Circuit boards?
A. If that's what you're talking about, yeah, circuit boards.
Q. Okay.
A. The tubes themselves. They were all components. So if a tube went bad, you could pull it and replace it.
Q. Okay. Circuit boards, you

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have to pull circuit boards yourself?
A. We would --
DEFENSE COUNSEL: Same objections.
THE WITNESS: There were two ways -- two kinds of ways to take care of circuit boards problems. One, you could find out if there was component that was bad, for example. Well, the tube I just mentioned. But they both have circuit boards.
But the transistor, you could detect a bad transistor and replace that. Sometimes, if you couldn't find the problem in the circuit board, then you replace it, yeah.
DEFENSE COUNSEL: Move to strike nonresponsive portions.
BY MR. PAUL:
Q. Was there any kind of cloth or pad inside the radios?
DEFENSE COUNSEL: Objection;

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BY MR. PAUL:
Q. What did you do as part of that second overhaul?
A. Let me back up a little bit. So it was an unusual type of situation because we took the ship to dry dock in Philadelphia. Our home port was Norfolk, Virginia. We took the ship to the dry dock in Philadelphia, Philadelphia Naval Shipyard.
And then we kept on board the crew that was needed to do the electronic overhauls that we were going to do at that point in time. Okay. We lived on the ship. We took every piece of equipment that was on the ship, including the stuff from before -- that we had before, plus the new equipment that came aboard, and we overhauled or did whatever maintenance was needed to update the -- to make sure all of the changes to the equipment that was already on board were done.
And, effectively, we took --

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except for the radars, I think every piece of equipment we had, we brought into the ET shop. And that was the main purpose for the ET shop.
DEFENSE COUNSEL: Objection; move to strike, lacks foundation.
DEFENSE COUNSEL: Move to strike nonresponsive portions.
DEFENSE COUNSEL: Can the court reporter read that last answer?
\- - -
(The court reporter read the pertinent part of the record.)
\- - -
DEFENSE COUNSEL: Move to strike speculative portions.
MR. PAUL: Okay.
THE WITNESS: Next, I heard -- are we still on?
MR. PAUL: We're still on. Yeah.
THE WITNESS: I mentioned that we didn't bring the radar in.

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I think we missed that somehow, but...
THE COURT REPORTER: I said that.
THE WITNESS: Oh, you did?
THE COURT REPORTER: Yeah.
\- - -
(The court reporter read the pertinent part of the record.)
\- - -
BY MR. PAUL:
Q. All right. Well, let's talk about what was in the shop, and then we'll talk about the radar.
What did you see done in the shop during the second overhaul in 1965?
A. I lived in that shop basically. I mean, I wasn't standing watches. I wasn't doing any of my other duties. I mean, there were two rooms on that ship. You don't walk around on the ship in dry dock much. I was either in the ET shop, or I was in my room sleeping.

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I saw every piece of equipment they brought in. I saw more than some of the ETs because they tend to work on certain pieces of equipment.
Q. What kind of maintenance --
DEFENSE COUNSEL: Move to strike the nonresponsive portions.
BY MR. PAUL:
Q. Okay. What kind of maintenance did you see performed on the equipment in the ET shop during the second overhaul?
DEFENSE COUNSEL: Objection; form, vague, compound, overbroad, lacks foundation.
THE WITNESS: It's a combination of different things they did. I forget the name they have for them, but they had -- I think they called them field changes. There was -- any type of a change -- as equipment aged, the Navy would make modifications. For example, they took some

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radios, and they maybe replaced them with other radios that were solid state. So that would be a case where they would -- we would actually lose a piece of equipment. We'd get a substitute for it.
But for the most part, we would just look for changes that could be made in the equipment that's already on board, that would update the equipment -- particular equipment.
We had -- other things that we did, if there were any tubes -- any electronic equipments that weren't working properly, we'd service them, just the same as we would have if we were at sea. The only real difference was -- focus was that we weren't at sea.
And we brought every piece of equipment we had on board the ship because they were all -- we

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could shut them all down. You can't do that when you're at sea.
BY MR. PAUL:
Q. Did you --
A. So we -- at least as a minimum, we'd take each piece of equipment, unless it had been done very recently, we'd clean it. If anything had to be adjusted, then we'd readjust it.
Q. What was the condition --
DEFENSE COUNSEL: Move to strike the speculative and nonresponsive portions.
DEFENSE COUNSEL: Can we move the microphone a little closer to the witness?
THE WITNESS: Oh, sure.
DEFENSE COUNSEL: Thank you so much.
BY MR. PAUL:
Q. What was the condition -- and this something -- we're going to go off the tape a minute -- what was the condition of the room where all this work

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was going on?
DEFENSE COUNSEL: Objection; form, leading, lacks foundation, assumes facts not in evidence, vague.
THE WITNESS: It was very cluttered. It was very busy. I think we covered -- I mean, we had two long benches in the ET shop. We had -- when you have 12 ETs and -- in that space, which was a pretty good size for a ship, it was just -- it was a place you couldn't keep clean. Let me put it that way.
MR. PAUL: All right. Well, let's go off the video for a minute because we have to change the tape.
THE VIDEOGRAPHER: This concludes video 1. The time is 12:16 p.m. We are off the record.
(Off the record.)
THE VIDEOGRAPHER: The time

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is 12:26 p.m. This is the beginning of video 2. We are on the record.
BY MR. PAUL:
Q. Okay. You were discussing earlier the equipment that was in the room. Okay? Are you able to -- today, to remember a specific one of the products that were -- that were on this chart that were in the room?
And I'm excluding the radar equipment for the moment.
A. Yeah, we didn't -- because we didn't bring the radar equipment in.
Q. Right. Of course, not. That's why I'm not asking about that.
A. It's too big.
I really don't, but I can say that our goal was to bring every piece of electronic equipment we had in. And even if we didn't do anything to it -- if we'd just, for example, maintained it, you know, the day before, we would at least check the card and make

going to get to that in a minute.
Do you recall being exposed to any particular ones of these products or not?
DEFENSE COUNSEL: Objection; form, vague, ambiguous, lacks foundation, calls for speculation, assumes facts not in evidence.
THE WITNESS: The answer is, no, I really don't recall any particular -- this was 50 years ago, and I have to stretch to remember some of the things I do remember. It's one of the reasons I did a lot of research.
BY MR. PAUL:
Q. Right. Well --
A. But I don't remember, you know, which equipment. I just -- all I know is all the equipment that Cambria had on board that ship was at least monitored and usually changed. But each one of them was brought down to the ET shop because everything was there for the

picking. We could take any piece of equipment.
We actually -- during this overhaul, we actually -- some of the crew from the shipyard actually moved walls. We changed some of the equipment around. Some ended up going into the flag officer's quarters -- or their offices, which are up -- high up in the ship. But every one of these pieces of equipment was there for us to take because nobody was using them. None of these people were aboard. And that's why we were very busy. And that was our function.
DEFENSE COUNSEL: Move to strike the speculative and nonresponsive portions.
BY MR. PAUL:
Q. You mentioned a radar?
A. Yeah.
Q. Is that a separate piece of equipment that was not worked on in the shop?
A. Yeah, it was too big. The

-- we had two radars, as I said.
DEFENSE COUNSEL: Objection --
THE WITNESS: The air search radar was very, very big.
DEFENSE COUNSEL: Objection; overbroad.
THE WITNESS: It had -- it was at the top of a mast. Actually, I'll just take them one at a time. That's the SPS 40. It was at the top of a mast.
BY MR. PAUL:
Q. That's the SPS 40, you said?
A. The AN SPS 40.
Q. Okay.
A. At the bottom of the mast was -- masts are huge on those ships. Okay. They're hollow. They're steel -- was a door that you -- when you opened the door -- and that's where the electronic equipment for the SPS 40 was located.
Similarly, the SPS 10, there

was another opening where that was maintained, and that was on a different mast. The SPS 40 was on one of the masts on the front of the ship. The SPS 10 was on one of the masts more near the center of the ship.
But they each had the two rotating antennas. There was a transmitter and a receiver to transmit a pulse, which would bounce off and then the receiver would receive it and amplify it. And it would show up on your -- the scanner that we had, the oscilloscope. I forget -- I forget the real name for the screen that the people that were on board -- CIC and ever who else -- we had what we called repeaters, where they could look, and they could see these blips, and they could interpret them as whatever, surface craft, aircraft.
DEFENSE COUNSEL: Move to strike the nonresponsive portions.
BY MR. PAUL:
Q. Did you, yourself, work on

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the electronic equipment in the SPS 10?
DEFENSE COUNSEL: Objection; asked and answered.
MR. PAUL: No, that is definitely not asked and answered.
THE WITNESS: No, I didn't. The only time I can remember working on one of the radars was in the SPS 40.
The SPS 40, when it worked, was a beautiful piece of equipment. You could pick up a target 300 miles, which is -- back in -- I believe, in 1964, '65, that was pretty phenomenal. But it broke down all the time. And it was the most modified piece of equipment we had on the ship.
We had a field -- a field rep who came out and helped get that thing operating. If there were field changes, updates that were made -- and there were several -- that's who would do it.

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It was a very, very special, state of the art in those days, piece of equipment.
DEFENSE COUNSEL: Move to strike.
THE WITNESS: And one time -- I did go out at least once -- but the captain was very, very upset when that was down.
And so I was on the field rep's back. If he was down there in that little room working on the radar system, I'd want to know what the problem is, how long is it going to take, do you have the parts that you need to repair it, and so forth, because -- just because of the captain. It was that and the other radar, the surface search radar, were two vital pieces of equipment that they didn't want to be without.
DEFENSE COUNSEL: Move to strike the nonresponsive portions.

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BY MR. PAUL:
Q. Do you remember who -- what company the field representative worked for, for the SPS 40?
DEFENSE COUNSEL: Objection; leading, lacks foundation, calls for speculation.
THE WITNESS: I want to say Raytheon. I'd have to go back and look. Because I actually found documents that showed all the different versions of the SPS 40 radar.
And I looked for the version when I was on board, and it definitely wasn't all solid state. It was partially tubes. It had a magnetron.
But I think we have -- in our records there, we do have -- matter of fact, I could look on here and see.
MR. PAUL: That's all right. I'm not asking what you --

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DEFENSE COUNSEL: Move to strike speculation and nonresponsive portions, improper refreshing of recollection.
THE WITNESS: No, it was the SPS 10 that was Raytheon. The SPS 40 --
DEFENSE COUNSEL: Improper refreshing of recollection.
THE WITNESS: -- I think it started out with Lockheed Martin, but then when they -- the company started to get sold and bought by other companies. It changed hands.
BY MR. PAUL:
Q. So you were --
DEFENSE COUNSEL: Move to strike speculation and nonresponsive portions.
BY MR. PAUL:
Q. How did you know that it was a Lockheed representative on the SPS --
DEFENSE COUNSEL: Assumes

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facts not in evidence --
MR. PAUL: Excuse me. I'm not finished asking my question. Could you please wait?
BY MR. PAUL:
Q. How did you know? Did he have a logo? Did he have a uniform? Did he give you a business card? How did you know?
DEFENSE COUNSEL: Same objections.
THE WITNESS: He was the only guy on board in civilian clothes. How about that?
DEFENSE COUNSEL: Same objections.
THE WITNESS: He was -- I worked with him when he came on board. He came to see me. I mean, that was part of my function. Okay? And so I knew who he was.
He didn't get to our ship a very easy way. Very often, he was

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transferred from another ship or a helicopter to get to us.
BY MR. PAUL:
Q. Do you remember his name?
A. It wasn't always the same guy.
Q. Oh, it was not always the same guy?
A. Yeah.
Q. Well, so the SPS 40 wasn't worked on just one time in your presence? It was worked on more than once?
A. Worked on a lot. Worked on a lot.
DEFENSE COUNSEL: Objection; leading.
THE COURT REPORTER: Can you say -- I didn't hear your answer.
THE WITNESS: Oh, it was worked on a lot, yeah. It was --
BY MR. PAUL:
Q. How often was the electronics worked on, on the SPS 40, in your presence?

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DEFENSE COUNSEL: Objection; vague, ambiguous, overbroad.
THE WITNESS: Well, it was only the one time that I know of that I was down there when they --
BY MR. PAUL:
Q. Okay.
A. -- opened it up.
Q. Okay. Were you ever in the other parts of the ship, like the engine room or the fire rooms?
A. When I went aboard the ship, I was given a complete tour. That included the engine room.
Q. Okay.
A. And the one thing I learned about the engine room is that I never wanted to go back there again. It was like 110 degrees and super dry. It's not the kind of place you want to go.
Q. Okay. I got you.
A. We used -- but we used cooling air from, like, in the winter, for example --

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Q. Uh-huh.
A. -- to help cool that part of the ship.
Q. Okay.
A. In other words, it's part of the ventilation system that we had which was --
Q. Was there any deck work or insulation of pipe work done in your vicinity?
A. Not that I recall.
Q. All right. Have we now talked about everything that you did in the Navy, or have we missed any jobs or activities that you had in the Navy?
A. Well --
Q. We've talked about the watch officer. Other than that -- and you talked about that, as well as the electronic work. Anything else other than the electronic work and the watch officer work that you can recall?
A. Yeah. I'm not sure this is really -- well, the other job I had was

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kind of a good job. I had -- I was in charge of -- I was called a special services officer, which is a fancy name, but I was in charge of recreation on the ship.

Q. All right. We'll pass over that.

A. Yeah.

Q. After -- I know what those guys do.

After you were in the Navy, what was your next job?

A. Next job is Control Data in Minneapolis.

Q. Now, you mentioned that a little bit before. Can you just tell us briefly what you did for Control Data?

A. I actually started off with -- well, I told you I was the crypto officer and --

Q. Yeah, you did. You did.

A. Okay. And eventually, I had a top secret clearance. So when I went looking for a job, I went to a job fair.

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It was in Philadelphia here. I can't remember where. And one of the companies that showed immediate interest -- and, later, I learned it was because I had a top secret clearance, which was good for the job I was going to have because they wanted -- they wanted me to redesign part of the targeting system for the flyover target card computer system, which is a system that targets the missiles. Okay.

And since I really didn't have any digital experience -- that's one piece of experience I didn't have much of when I was in Penn State because the digital world was just starting, and a lot of it was pure mathematics -- they sent me to their own school. There was no place to get an education at that time on digital design.

Q. But, basically, your job with Control Data had to do with the missiles, primarily, right?

A. It had to do with redesigning part of the equipment,

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electronics equipment, which happens to be -- they wanted a keyboard --

Q. Right.

A. -- that they could communicate with more and quickly target, without going through the old process, which was very laborious.

Q. After Control Data, where did you go to work?

A. I went to work at GE.

Q. And which facility of GE did you work at first?

A. Valley Forge --

Q. And what did you do --

A. -- Pennsylvania.

Q. What did you do out there in Valley Forge?

A. My initial job was to design circuitry for aerospace ground equipment. What that is, that's the equipment that -- the equipment that you see these people that we send a missile up, for example, that sit there and control the missile. They did the same thing for

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satellites. They had people that sat there and controlled satellites.

And so that's the kind of equipment that I was designing. That was my first job there.

Q. How long were you in Valley Forge?

A. I have to look at my list.

Q. Approximately.

A. You've got the dates.

Q. Approximately.

A. A couple of years.

Q. Okay. And while you were at Valley Forge, were you ever near any pipes in the plant?

DEFENSE COUNSEL: Objection.

THE WITNESS: Not that I remember.

BY MR. PAUL:

Q. You don't know one way or the other, or you think not, or you think yes?

A. Well, I knew that -- what they did at Valley Forge, they were -- at

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that time, they were going crazy. They had so many jobs, and they didn't have enough room for everybody. So they actually converted bathrooms into offices, you know, without any windows or whatever.
So they would -- in tearing up the bathrooms, did they expose any pipes? I mean, I don't know. That would be pure --
DEFENSE COUNSEL: Move to strike nonresponsive portions.
BY MR. PAUL:
Q. You have no idea?
A. I don't know. Yeah. That's the only information I have.
Q. Okay. Do you remember any of the people you worked with at Valley Forge?
A. One in particular.
Q. Who was that?
A. I'm trying to remember his name here. Now you're testing me. Ted Venticinque.

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Q. Venticinque?
A. Yeah.
Q. Do you know where --
A. Ted 25.
Q. Do you know where he lives?
A. Not anymore.
Q. Or lived at the time --
A. I lost track. But he lived in -- that inexpensive housing, which I can't remember the name of, over in New Jersey, though. Levittown.
Q. Levittown. I was going to ask -- I meant to ask you one question -- go back to the Navy for a second --
A. Yeah.
Q. -- did you ever see a warning label about asbestos?
DEFENSE COUNSEL: Objection; leading, form, assumes facts, calls for speculation, overbroad.
THE WITNESS: Not that I recall.
BY MR. PAUL:
Q. Did you ever see warning

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labels about electrical problems?
DEFENSE COUNSEL: Same objections.
THE WITNESS: About electrical?
BY MR. PAUL:
Q. Electrical problems, avoid high voltage, anything like that?
DEFENSE COUNSEL: Same objections.
THE WITNESS: If it was there, I didn't -- although, go back to Control Data, one of the problems they were going on the Polaris missile system had to do with the power supply crashing. Okay. And they couldn't figure out why because the current would climb out of sight.
So my first assignment there -- well, while I was going -- or after -- it was before I went to school -- was trying to find the problem that caused that surge.

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So maybe that was while I was waiting to get into school. I don't remember.
But that's the only experience with high voltage equipment. And there were warning symbols in there.
BY MR. PAUL:
Q. There were?
A. Yeah.
Q. And you followed whatever warning signals there were?
A. Yeah. I just -- well, I knew what not to touch. I learned that going back to my days when -- Howdy Doody days --
Q. Okay.
A. -- when I didn't realize that just because you pulled the plug on the TV didn't mean there wasn't a $300 -- 300-volt charge in there.
Q. Did you work for GE anyplace else?
A. Yeah. I moved to -- we're

EXHIBIT D

IN THE COURT OF COMMON PLEAS

PHILADELPHIA COUNTY, PENNSYLVANIA

\- - -

ROBERT J. KRAUS and MARGARET M. KRAUS, h/w	:	APRIL TERM, 2018
v.	:	
ALCATEL-LUCENT, et al.	:	NO. 3448

\- - -

November 28, 2018

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Videotape discovery deposition of ROBERT KRAUS, taken pursuant to notice, was held at the offices of Magna Legal Services, 1635 Market Street, Philadelphia, Pennsylvania, commencing at 9:40 a.m., on the above date, before Melissa Broderick, a Professional Court Reporter and Notary Public for the Commonwealth of Pennsylvania.

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didn't work like the captain wanted me to work. So we solved our problems ourselves.
Q. Okay. And is this the SPS 40 here?
A. Yeah.
Q. And I think earlier --
A. Can I just -- let me take a look.
Q. Sure. Yeah, yeah, yeah.
A. I'm guessing from a distance.
MR. PAUL: I think, for the future, it might be a better if you put a circle around where the SPS 40 is.
BY MR. SMITH:
Q. Yeah. Can you circle the SPS 40 mast, the mast?
THE VIDEOGRAPHER: There's a highlighter here.
THE WITNESS: I can just circle.
MR. SMITH: You can circle,

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yeah.
How much time do we have?
THE VIDEOGRAPHER: Under five.
MR. SMITH: Okay.
THE WITNESS: Then I can do it on this one here also.
MR. SMITH: Just one of them. The first page is fine.
THE WITNESS: You can see it very clearly. The SPS 10 would be behind this.
MR. SMITH: Well, we're --
THE WITNESS: Oh, okay. This helps even more.
BY MR. SMITH:
Q. Right now, this is just for -- you know, I just want to ask about that. We can move to that at some other point.
But just circle the first page with the SPS 40, so we don't confuse people.
A. That's already circled.

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Q. Okay. Excellent.
Yesterday, you said that one time you saw work performed on the SPS 40. Do you recall that testimony?
A. Yes.
Q. When exactly did that take place?
A. Did you say when?
MR. PAUL: I'll take the pen back.
THE WITNESS: Oh, sorry.
MR. PAUL: Listen to the question.
THE WITNESS: Yeah, I heard the question. He was asking when I actually saw work performed on the SPS 40, as I understand.
I just lost it. When, you said. I don't recall when. I know that we had a lot of problems with it. It was like -- I was on the ship three years, and we had problems with the SPS 40 all three years.

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We had tech reps that came out and spent time on the ship. So I don't know the answer to that.
MR. SMITH: Move to strike the nonresponsive portions.
BY MR. SMITH:
Q. I just want to go through this in an ordinarily manner. So if you can answer the question yes or no.
A. All right.
Q. If you need to explain, that's fine, but it will be a little bit quicker.
A. Right. Okay.
Q. Can you estimate at what point in time you saw work performed on the SPS 40? Like, the first year or second year or third year. Maybe not a specific date, but just towards the beginning, towards the end. And if you can't, that's fine.
A. I really don't know. It was sporadic. I didn't always go when the

EXHIBIT E

IN THE UNITED STATES DISTRICT COURT

FOR THE EASTERN DISTRICT OF PENNSYLVANIA

ROBERT J. KRAUS and
MARGARET M. KRAUS, h/w,

Plaintiffs,

vs. No. 18-2119

ALCATEL-LUCENT, et al.,

Defendants.

VIDEOTAPED DEPOSITION OF ROGER GOSSETT

Suffolk, Virginia

Tuesday, August 20, 2019

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REPORTED BY: DEBRA-LYNN BAKER, RPR, CSR

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A Yeah.
Q -- what did you have to do to that wire?
And, again, I'm talking about the 390 for the moment. I'll get to some of the other stuff in a bit.
A Well, it's just a matter of determining, you know, you need a wire that's this long or that long, you cut it off, you strip the ends off of the insulation off the wire to expose the conductor and solder it back into place --
Q Okay.
A -- whether it's, you know, 2 inches long or a foot long.
Q What happened when you -- when you cut the wire, as you describe it? Did you see anything happen, or did you see anything in the air?
DEFENSE COUNSEL: Objection; form.
BY MR. PAUL:
Q You can answer the question.
A No. Well, when you cut the wire, the insulation -- you have special cutters for the wire which, you know, will cut the insulation but

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not the wire.
Q Yeah.
A And once you cut it, the insulation goes flying into the trash can or on the floor.
Q Did it ever fly in your face?
DEFENSE COUNSEL: Objection to form, leading.
THE WITNESS: No.
BY MR. PAUL:
Q Okay.
A You've got to be careful, you know, you don't do things like that.
Q Right. Were there any other pieces or components of the R-390 that you recall?
A Mechanical components.
Q Well, tell us about electronic.
A Yeah.
Q Okay. What's a resistor?
A A resistor is a piece of electrical equipment that's made to -- to impede the flow of electronics, and how much it impedes it depends on how it's made. You can get them that are very low resistance or very high resistance --
Q Okay.
A -- and --

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Q Do you know how they're made?
A Basically, yeah. A bunch of -- first of all, the engineers determine what resistance they need. Okay? They're made in certain steps. The compounds that -- the resistive conductive compounds are chosen to provide this plus-or-minus resistance.
Q Okay.
A And then they're incorporated into a package with other stuff to keep them -- what can I say? To keep it together --
Q Okay.
A -- okay, with two wires sticking out the end.
That -- that's strictly the -- the manufacturing process. Okay? That has nothing to do with my end where I --
Q Sure.
A -- replace the resistors.
But that's -- yeah, that's --
Q Do you know any --
A -- that's basically how I -- how I know a resistor is made.
DEFENSE COUNSEL: Move to strike, lacks foundation, basis of foundation,

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speculation.
BY MR. PAUL:
Q Do you have any knowledge about what the compounds were made of?
A No, I haven't the slightest.
Q Now, we're talking about the 390 for the moment.
A Okay.
Q Was there a difference in resistor -- well, were resistors used in lots of other -- in other equipment?
A Yes.
Q Okay. What other pieces of equipment were the resistors used in that you recall?
DEFENSE COUNSEL: Objection. Again --
THE WITNESS: Every piece of electronic equipment on the ship has resistors in it.
BY MR. PAUL:
Q Okay.
A Whether it has -- you know, the number is -- depends on the complexity of the equipment. Some of the -- the transmitters had hundreds of resistors.

Q Okay.
A Some of the smaller components had two or three.
Q Okay. Well, take the ones that had hundreds. Can you recall which ones had hundreds of resistors in them?
DEFENSE COUNSEL: Object to form.
THE WITNESS: The SRT series transmitters. They were -- they were monstrous equipment that -- they stood 6 feet tall and 3 feet wide and 3 feet deep.
BY MR. PAUL:
Q Okay.
A And there was a lot of electronics in it.
Q Okay. Well, let's talk -- well, all right. The SRT-13, let's --
A Yeah --
Q -- see if I can --
A -- SRT-14, 15, 16.
(Plaintiffs' Exhibit 12 was marked for identification by the court reporter.)
BY MR. PAUL:
Q Okay. All right. Let's turn to what

I have previously marked as P-12. Okay. This is the SRT, not the SRR-13, this is the SRT-13.
A SRT --
Q Okay.
A -- yeah, 14, 15, and 16.
Q Let's see if I have --
A It's T for transmitter.
Q All right. Hang on a second.
Let's go off the video for a moment, please.
THE VIDEOGRAPHER: We're off record at 9:40 a.m.
(Discussion off the record.)
THE VIDEOGRAPHER: We are back on record at 9:41 a.m.
BY MR. PAUL:
Q Is there a difference between an SRT-13 that you just mentioned --
A The SRT series, there's a 14, 15, and a 16.
Q Okay. Are they all about the same, then?
A Well, like I said, the SRT was a smaller 100-watt transmitter.
Q Right.

A As far as physical appearance, it's probably 5 feet tall --
Q Okay.
A -- a foot, a foot and a half wide, and a couple of feet deep.
The SRT-15 is an SRT-14 with an amplifier beside it which --
Q Okay.
A -- doubles the width.
Q Okay.
A Okay? And an SRT-16 is an SRT-14 and an SRT-15 combined. So you -- in an FR -- SRT-16 you have -- basically have two transmitters, a hundred-watt transmitter and a 500-watt transmitter, both of which operate independently.
THE VIDEOGRAPHER: You're covering your mic.
BY MR. PAUL:
Q All right. We talked about -- you mentioned an SRR-13.
THE VIDEOGRAPHER: I'm sorry, you're covering your microphone, sir.
MR. PAUL: Oh, sure.
THE WITNESS: Oh, okay.
BY MR. PAUL:

Q You mentioned the SRR-13?
A SR- -- I'm not sure on the S- -- it's an SRR -- it's a receiver.
Q Okay.
A A small thing about this tall --
Q Okay.
A -- and 19 inches wide.
Q Okay.
A It's used mainly strictly to receive. Again, it's a piece of electronic equipment. It's fairly complex.
Q Okay.
A But --
Q So it has resistors in it?
A Yes, it does.
Q Anything -- any other pieces of equipment that it has in it?
A Everything -- every piece of electronic equipment has resistors in it.
Q Okay.
A Okay? Like I said, it may be 3, it might be 200.
Q Okay. What's a capacitor?
A A capacitor is an electronic component that is used to store electrical energy

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or to pass a signal through, depending, again, on the way it's built.
Q And were there capacitors on the Cambria?
A Oh, yes.
Q Tell me about that.
A Well, capacitors are just about as ubiquitous as resistors are in most electronic equipment.
Q Okay.
A Yeah, it's -- you know, today, with the integrated circuits and all this stuff, they're -- they're out of sight. But back then, you made electronic equipment out of resistors, capacitors, tube sockets, coils, you know, various small parts.
Q Okay. What's -- how is a capacitor made, if you know?
DEFENSE COUNSEL: Object to form; calls for speculation.
BY MR. PAUL:
Q You can answer the question.
A Capacitor? Well, let's see. The basic capacitor is two pieces of conducting material, aluminum, copper, whatever you want to

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call it, with an insulating material in between rolled up into a small or a large, depending on what you -- you're building it, so that the two wires connecting the two different metal plates or conductive surfaces --
Q Okay.
A And it can be an itty-bitty little thing like, you know, your fingernail, or it can be that big and stand a foot tall, again, depending on what you're building it for.
Q Okay. What's this insulat- -- if you know, what's the insulating material that you just described a minute ago composed of, if you know?
DEFENSE COUNSEL: Object to form, calls for speculation.
THE WITNESS: The only materials that I know of personally, because I have taken capacitors apart on occasion, just out of curiosity, is wax paper or some type of insulating paper with something on it to keep it from drying out and then wrapping the whole shooting match in -- in a coat -- coating to protect it from the environment.
BY MR. PAUL:

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Q Okay. Do you know what this insulating paper that's not wax paper was made of, if you know?
A No, I do not.
Q All right. You mentioned -- I am going down -- URR-13?
A Yeah. I believe that is a -- if I remember correctly, that is the UHF receiver --
Q Okay.
A -- ultra high-frequency receiver.
Q Is -- is there a difference in the composition and the -- and the -- of that product from these others that you have mentioned so far?
A No. The only difference is the frequency range in which they operate.
Q Okay. They all, basically, are designed and constructed the same way?
A Yes.
Q Okay. They came in a box, like in a metal box?
A Yes. Everything came -- come in a metal case. Especially, you know, being shipboard, it has to be ruggedized for --
Q Sure.
A -- when we're having fun in the open

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ocean.
Q Sure. Did -- did -- do you recall if there was any cloth or board or paper inside the box or any other kind of material inside the boxes?
DEFENSE COUNSEL: Objection; leading.
THE WITNESS: No.
BY MR. PAUL:
Q Okay.
A Now, most -- most all shipboard equipment is made ruggedized with metal, aluminum or steel --
Q Right.
A -- or whatever, you know.
Q Sure.
A There -- there's hardly any -- paper or light material like that would -- would be fragile.
Q Okay.
A It's hardly ever used on shipboard.
Q Okay. Do you remember any board, any heavy board or anything like that inside metal boxes?
DEFENSE COUNSEL: Same objection.
DEFENSE COUNSEL: Objection; asked

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and answered.
BY MR. PAUL:
Q You can answer.
A Well, circuit boards are made in some of the equipment to plug in and, you know, circuit boards are made of fiberglass, to my knowledge, with the components mounted on them and then some sort of a clear plastic, plastic used in the generic sense, some kind of a sealer to prevent them from getting wet, getting dirty.
Q Do you recall any particular pieces of equipment that had circuit boards?
A Oh, yes.
Q Okay. Go ahead.
A Yeah. The cryptographic equipment, especially, had many circuit boards in it. That's the KWR-26 and the -- KWR-37, the KW-26, KW-7s, they were all pretty much modernized up to where they had 90 percent circuit boards.
Q Okay. And did you have -- where were these -- you did maintenance on these products?
A Yes.
Q Okay. And what part of the ship was that done in?
A Well, if you maintain a circuit

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board, you pulled it out of the equipment, brought it down to the shop and troubleshot it right there in the --
Q Okay.
A -- in the shop.
Q Okay. When you opened up the equipment, what did you have to do to the equipment? And, again --
DEFENSE COUNSEL: Object to form, as overbroad.
BY MR. PAUL:
Q Again, we're -- we're talking about either the SRR-13 or the SRR-11 or the 390A or the URR --
DEFENSE COUNSEL: Same objection.
THE WITNESS: Yeah. Well, you know, depending on how the thing is made, it's -- once you get the equipment open to where you can get at the insides, there's a couple of screws or many screws that you have to take loose to get the module or the circuit board out.
BY MR. PAUL:
Q Okay.
A Pull it out, take it to the shop and fix it.

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Q Did you ever have to use a vacuum cleaner?
A Yes.
Q Tell me about that. Why would you use a vacuum cleaner?
A Probably once a month, every couple of months you'd open the equipment up, vacuum it out, because dust collected in there, and it was part of our -- let me see. The name of the system was POMSEE. I don't, exactly, know what that stands for, but it was a preventative maintenance shipboard electronic where you cleaned the place out and made sure that everything was pretty and put it back together so that the dust did not accumulate.
Q Now, when you say once a month, you're talking about -- are you talking about once a month in the shop or once a month for each piece of equipment?
A Once a month --
DEFENSE COUNSEL: Objection; misstates his testimony.
THE WITNESS: Once a month for each piece of equipment. You know, you had a regular schedule --

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BY MR. PAUL:
Q Okay.
A -- that -- you know, and -- and you had a little book, you had to sign it saying, yeah, yeah, we did it.
And you open it up, clean it out, clean the air filters, if so --
Q Okay.
A You know, if it had an air filter in it, and basically make sure it was lubricated and cleaned, put it back together. As long as it was working, leave it.
DEFENSE COUNSEL: Move to strike nonresponsive portions.
BY MR. PAUL:
Q During the time you were on the Cambria, how many pieces of equipment were maintained or repaired using the vacuum cleaner system that you have described in the shop itself?
DEFENSE COUNSEL: Object to form, calls for speculation, misstates the witness's testimony.
DEFENSE COUNSEL: Lacks time and scope.

THE WITNESS: I can't really say. In the shop, I would say very little use of the vacuum cleaner in the shop, because we normally take it to the equipment, open the equipment up, vacuum it, clean it, whatever, and lubricate it, put it back together.

BY MR. PAUL:

Q You say -- you are talking about not in the shop but someplace else on the ship?

A That is correct.

Q Okay. All right. You mentioned the UR -- WRT-1 and the --

A Yes.

Q -- TED.

Tell me about those pieces of equipment.

A Well, WRT-1 is a transmitter, a low-frequency transmitter, which every ship, major ship, has one. It's basically the same size as the SRT, a little bit larger, again, specifically designed to transmit in low-frequency range as opposed to the high-frequency range.

It's a lot of tubes, slide-out drawers. You know, it's a pretty complex piece

of engineering, and it worked pretty good. Every once in a while, you know, a tube would go bad or something like that, but a pretty good piece of equipment really.

Q Okay. All right. I am going to -- sir, I am going to ask you to look at what has previously been marked as Plaintiffs' 12 and Plaintiffs' 14.

And let's go off the video while he goes through those.

THE VIDEOGRAPHER: Go off record at 9:51 a.m.

(Discussion off the record.)

(Plaintiffs' Exhibit 14 was marked for identification by the court reporter.)

THE VIDEOGRAPHER: We are back on record at 9:52 a.m.

BY MR. PAUL:

Q Okay. Sir, what -- what are you seeing in these pictures?

A This is an SRR-13 receiver.

Q Okay.

A And pretty much the way it's mounted on a ship in its own individual cabinet.

Q Why don't you hold that up to the -- to the jury can see it and point to it, what you're talking about.

Is that the top --

A Yeah, here.

Q -- one?

Okay. That's what it looks like?

A Yeah, basically.

Q All right.

A This thing is bolted or -- or, you know, in a -- on a table or a mounting of some kind. The picture here shows you how to get it out of the cabinet.

Q Okay.

A Just pick the handles up and hold them up and slide it out. Once you --

Q What would happen -- let's start -- what would happen when you would pull out the -- pull the piece out like that? What would happen, if anything?

A It comes out to -- to the end of the stop. It won't go any farther.

Q Okay.

A I mean, you know, you can leave it hang there, if you so desire.

Q Okay.

A But it -- it will tilt up and down so you can look at the top and the bottom, or you can push the buttons on the rail and take the whole thing out and take it to the shop and work on it if -- you know, if it's necessary.

Q Now, the bottom picture, that's when it's actually -- the whole thing is removed?

A Yeah. That -- that's how to take it --

Q Why don't you show that to the --

A -- off of the --

Q Show that to --

A -- off of the sliding rails.

Q Show that on the video, too, if you would.

A Yeah, right here.

Q Now, you mentioned dust before. Was there dust when you removed this, when you did this job?

A Well, normally this type of receiver, because it's built specifically for shipboard use, is fairly airtight. There has to be some circulation to let the heat get out, but normally the thing is cooled off with an internal fan and

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an air filter.
One of the purposes of removing this thing, like it's shown here, is to get at the air filter and make sure it's clean air back in the back of the equipment or, you know, anything that's accumulated.
Q Okay. And, in fact, there was -- you personally recall seeing dust accumulated when these were removed?
DEFENSE COUNSEL: Object to form, leading.
BY MR. PAUL:
Q If I've -- if I'm stating correctly -- tell me if I'm stating correctly what you --
A Yes.
Q -- just said.
A There -- there were occasions when there were dust inside the equipment.
Q Okay.
A Yeah.
Q Now, was this unique to the SRR-13, or was that true generally?
DEFENSE COUNSEL: Object to form.
THE WITNESS: No, that's pretty much

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generally every piece of equipment. The -- the amount of dust, dirt, crud, whatever you want to call it, that accumulated depended on the design of the equipment, how much air could actually get in from outside.
And like I said, normally these things are designed to prevent dust from getting in, but you can't make them totally dust-proof.
BY MR. PAUL:
Q Okay. Are these -- is this -- are most of these transmitters and receivers high temperature?
DEFENSE COUNSEL: Object to form; calls for speculation, vague.
THE WITNESS: In my opinion, yeah, you've got to watch out. Especially the tubes --
BY MR. PAUL:
Q Okay.
A -- you know, tubes are -- don't grab them until they cool down.
Q And each of these had -- the SRRs and some of these other pieces of equipment you have talked about --
A Yeah.
Q -- all had tubes in them?

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A Yeah.
Q Okay. And they were hot to the touch, you say?
A Yes.
DEFENSE COUNSEL: Objection; leading.
(Plaintiffs' Exhibit 13 was marked for identification by the court reporter.)
BY MR. PAUL:
Q Okay. Turn to what's marked on the bottom as LMCKR 39. Do you see that one? It says "Section 4" on the top. "Section 4" on the top.
A 39? Oh, okay. Let me see here. 31 -- okay. Oh, 39. Okay.
Q Do you see it?
A Yeah.
Q Okay. What do we see here?
A Okay. This looks like removing parts from the internal of a receiver. On this upper picture, you can see the mechanical couplings here where the --
Q Can you hold it --
A -- outside dials and so forth --
Q Hold it this so way so the camera can

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see it. Go ahead.
A This here?
Q Yeah.
A Okay. Once you get the -- the thing mechanically decoupled, you -- you can pull it out or, as shown in the bottom picture, you can take out a plug-in board.
Q Okay.
A Yeah. This one, the plug-in board there shows resistors, capacitors, whatever you want to call them, and the connecting pins so that they will hook into the -- the main chassis.
Q Can you show me or tell the jury which is the resistors and which are the capacitors in this picture, if you can see them?
A Yeah. Okay. On -- right here, this little darkish thing with the stripes on it, okay, is a resistor.
Q Okay.
A Okay? The stripes indicate the -- the particular resistance of the resistor.
Q Okay.
A The size of it indicates whether it's a half a watt, 1-watt, 2-watt, whatever.
Q Okay.

A The other 1, 2, 3 -- four little items shown here next to it appear to be capacitors.
Q Okay. Okay.
A Although, you know, I can't really see what it says on there, but it's -- it -- to me, it looks like capacitors.
Q Now, on the -- on the bottom, I guess, left there's a -- there's a little cartoon of a sailor.
A Yeah.
Q Is he basically holding the piece of equipment that we're talking about --
A Yeah, the --
Q -- the board?
A What he has in his left hand holding up is --
Q Show that to the jury, please.
A -- is the board that is shown as being removed here.
Q Okay.
A The -- in his right hand is the receiver where the board plugs into.
Q Okay. How often during your time on the Cambria did you see this operation go on?

A Quite a few times.
Q Okay.
A I would say -- well, let's see. I was there -- what was it? Three and a half years.
Q Right.
A Two and a half years? Whatever.
Q Before we go on to the next picture -- before we go on to the next picture, this -- the cartoon of the sailor -- okay?
A Yeah.
Q What, if anything, would -- would you -- did you see when this piece was removed?
DEFENSE COUNSEL: Object to form.
THE WITNESS: When -- when the board he's holding --
BY MR. PAUL:
Q Yeah.
A -- was removed?
Q Yeah. What, if anything, did you see?
A Well, you can -- you can in the main picture here --
Q Right.
A -- you can see down inside there's --

there's other components in there --
Q Okay.
A -- connectors, more capacitors, it looks like a resistor or two --
Q Okay.
A -- a couple of sockets for the thing to plug into.
Q Okay.
A And it's -- you know, the cartoon of the --
Q Right.
A -- of the sailor --
Q Right.
A -- shows it at basically an empty hole --
Q Right.
A -- which is -- that's not true.
These things are built pretty tight.
Q Okay. Were -- was anything inside there that you saw frayed or worn?
DEFENSE COUNSEL: Objection.
THE WITNESS: Well, that's one of the reasons for taking the pin out, is to check for frayed and worn things. If you see something frayed and worn, you would take that module

that's shown there --
BY MR. PAUL:
Q Right.
A -- and probably go to the shop and see if you can replace the frayed or worn part.
Q Okay.
A Normally speaking, the only -- in -- in this subassembly here that's shown being pulled out, the only thing that would get frayed, worn, or broken is the pins itself on the bottom of the -- the assembly shown in -- being pulled out or, like I said, occasionally a tube bad or --
Q Okay.
A -- a resistor, whatever.
Q All right. So there's a tube or a resistor in this particular piece of equipment?
A Oh, yeah. Yeah.
Q Now --
A It's not visible, but --
Q Okay.
A -- there is.
Yes.
Q Now, in order to -- so we don't have to go through the same procedure with each of the

shop where we could -- had the room and the tools --
Q Okay.
A -- to take it apart and do what we had to.
Q Okay. Did you ever work on the antennas?
A Yes.
DEFENSE COUNSEL: Object to form.
BY MR. PAUL:
Q Tell me about that.
A Well, the antennas were -- most of them were -- were pretty good. There was hardly any work that needed to be done, as far as repair.
The main thing that had to be done on the antennas was the transmitting and receiving antennas had a big insulator on the bottom, which accumulated saltwater -- or salt spray, I should say, and dust and dirt, whatever, and every once in a while they had to be cleaned off just to maintain proper operation.
Q Do you recall how often you had to clean them off? And, again, I am confining, you know, to your time on the Cambria.

A Yeah. I think about every three months. I'm not sure of -- of the exact schedule, but roughly every three months --
Q Okay.
A -- they had to be cleaned.
Q Do you remember any numbering or nomenclature to describe the antennas?
A Most of the antenn- -- we had two kinds of antennas for the communications, what we call a 35-foot whip, which was an aluminum 35-foot long antenna which came in four sections, I believe, and mounted on this large antenna insulation that I mentioned, then we also had wire antennas.
Q I'm sorry, wiring?
A Long wire antennas.
Q Oh, wire antennas?
A A big --
Q Okay.
A -- copper, bronze cable that we ran between one mast and the other and then down to an end insulator where the transmitter fed into it.
Q Do you remember any numbering for these transmitters? For these antennas, I should

say.
A No. The 35-foot whip, I know it was AS dash something or another, but I don't remember exactly what it was.
Q Okay.
A The long wire antennas, it was however piece of long wire you needed. There was no number.
Q What does the term -- do you know what the word "SPS-40" means?
A SPS-40, yes. That's a --
Q What's that?
A -- radar system, air search radar.
Q Okay. And that's different from what I'm talking about with antennas?
A Yeah. Well, the SPS-40 antenna itself is -- it's unique to the radar. It's a rotating antenna which mounts up as high as we can get it, and it's fed by a wave guide from the -- not a wave guide, but a -- okay. We called it a wave guide, but it was actually a coax, hard coax.
Q Okay.
A And the antenna maintenance itself, it never needed anything done.

Q Okay.
A I mean, you know, the -- the rain cleaned it off. We -- as long as the motor made it go around and the connections were made between the antenna and down below, it didn't do anything.
Q Were there pieces of the SPS-40 that had to be maintained or worked on?
A Yes.
Q Let me show you what's been previously marked as 6.
(Plaintiffs' Exhibit 6 was marked for identification by the court reporter.)
THE WITNESS: Okay.
BY MR. PAUL:
Q Is that what we're talking about, the SPS-40?
A Yes. That's the SPS-40 antenna. Yes.
Q Okay. All right. The second page of that document, what is that document to you?
A Okay. This is a system diagram of the entire SPS-40 system, transmitters, receivers, antennas, everything, all the

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electronics that are needed to make the whole thing work.
Q Okay. What parts of the SPS-40 did you and the men working for you have to work on?
A Okay.
DEFENSE COUNSEL: Assumes facts not in evidence, misstates testimony.
THE WITNESS: In the --
BY MR. PAUL:
Q And if you are able to, hold it up to the --
A Oh.
Q -- to the picture --
A Sorry.
Q -- and show that to the jury.
Go ahead.
A Okay. The antenna up here is the one that I said, you know, pretty much it's -- unless something broke --
Q Okay.
A -- we hardly ever had to work on it.
Q Okay.
A But the -- the controls -- the electronics, it's rather complex.
Q Why is it complex? When you say

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complex, why do you mean that?
A Well, it's -- it's a lot of pieces of equipment here.
Q Okay.
A After I left the Cambria, later on in my career I had an opportunity to serve as an instructor for the SPS-40 alpha radar system at Naval Training Center --
Q Okay.
A -- Norfolk.
Okay? So I'm quite familiar with how complex it is.
Q Okay.
A Okay?
Q Tell me what kind of work had to be done on this, on this SPS-40.
DEFENSE COUNSEL: Object to form.
THE WITNESS: Well, again, it's -- it's pretty much the type of thing which -- which works as long as it works.
There was one guy, Stubblefield, Dave Stubblefield --
BY MR. PAUL:
Q Right.
A -- was the technician who had gone to

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school on this, and he pretty much knew how things worked.
Okay? And whenever anything went wrong with the -- with the 40, Stubblefield was the guy you called.
Q Did -- we have talked about a number of different pieces of equipment. We talked about receivers, transmitters --
A Yeah.
Q -- transceivers, resistors --
A Right.
Q -- capacitors --
A Yeah.
Q -- wire and cable.
We talked about a lot of products so far.
A Yes.
Q Which, if any of those products, was on this SPS-40 system?
A All of them.
Q Okay.
A I mean, you know, it's a real complex system. Okay?
Q Stubblefield was the one that primarily worked on that?

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A Yes.
Q Okay. Did you ever see Stubblefield and Kraus together when Stubblefield was working on the SPS-40?
A No, I did not, but that was because the SPS-40 in -- in the radar room, everything was, you know, pretty much filled up. They -- they didn't allow for a whole lot of room.
Q Okay.
A And if Dave Stubblefield was in there working and Mr. Kraus was in there with him, there's no more room.
Q Okay. Was it part of Kraus's job to monitor what Stubblefield was doing?
A Yes, yes. He was part of the -- the electronics gang.
Q Okay.
A He was the radar -- part of the radar section.
Q Stubblefield was?
A Stubblefield.
Q You say "He." I'm just trying to --
A Yeah. He, Stubblefield, was -- was part of the radar section. Yeah. Mr. Kraus was in charge of the radar section and the COMM

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section where I was.
Q Okay. Okay. Anything else about the SPS-40 you want to tell me about?
A Had a lot of problems with it.
Q What kind of problems?
A Because it was an initial -- one of the newest systems in the navy. And when you get a new system, it's got a lot of bugs in it. Okay? And so Stubblefield was basically beating his head against the wall all the time, trying to figure out what was going on.
And we had, on occasion, a couple of what we call tech reps, technical representatives come aboard who would -- from the manufacturer or whatever, somebody that was supposed to be more of an expert than -- than Stubblefield was --
Q Okay.
A -- to try and help him out.
Q Do you remember --
DEFENSE COUNSEL: Move to strike nonresponsive portions and based on speculation.
BY MR. PAUL:
Q Do you have any recollection of what company they were from, these tech reps?
A No. I assume they were -- well, let

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me put it this way. The ones that came from the manufacturer, obviously, I -- I don't know who manufactured the thing, but the tech reps also came from an organization called MOTU, Mobile -- Mobile Technical Unit 2, I believe it was, MOTU-2 in Norfolk, who were supposed to be experts on this radar.
Q So they were civilians?
A And -- and they would -- yeah. Well, they were civilians or senior navy.
DEFENSE COUNSEL: Move to strike on same grounds.
BY MR. PAUL:
Q Did you ever see anybody from Lockheed --
DEFENSE COUNSEL: Objection.
THE WITNESS: Not to my knowledge, no.
BY MR. PAUL:
Q -- work on the SPS-40?
Okay.
A You know, like I said, whoever made it --
Q Okay.
A -- it might have been Lockheed, it

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might have been somebody else.
Q Okay.
DEFENSE COUNSEL: Move to strike on same grounds.
BY MR. PAUL:
Q Do you know whether the S- -- particularly from your later experience with the SPS-40, there are different versions of it, right?
A Yes.
Q There's an A, B, C, D, and E?
A Yeah. Yeah. Well, there's -- yeah, the 40 itself --
Q The 40, the regular 40, and then --
A Yeah. Then the -- then the 40 alpha, 40 bravo, 40 Charlie, and finally 40 delta. Yeah.
Q Do you know which one was on the Cambria?
A It was the 40.
Q The straight --
A The basic one, yeah.
Q The straight 40. Okay.
A Yeah.
DEFENSE COUNSEL: Move to strike,

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same grounds.
BY MR. PAUL:
Q And why do you know it was the 40?
A Because it was one of the newest ones that came out.
Q Okay.
A And when I -- later, my experience with the 40 alpha, when I was teaching that, I knew it came -- it was -- came out after I left the Cambria.
Q Okay. Oh, okay. That the 40 alpha was later?
A Yeah.
Q Okay. That's why you know that?
A Yeah.
Q Okay. Any other work that had to be done that Stubblefield had to do on the 40 that you recall?
A No.
Q We talked about --
A It was driving him nuts.
Q Okay. All right. Okay. We have talked about the 390.
A Yeah.
Q Anything else about the 390 you want

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to talk to me about?
A It was a good receiver. I wish I had one.
Q All right. Do you know what an SPS-10 is?
A Yes.
Q What is that?
A SPS-10 is a surface search radar, which is used to determine where any ships and other landmarks are within -- I don't know -- 50, 60 miles of the -- of the ship. It had a rotating antenna on top also, smaller than the SPS-40 antenna, but it was a good system. It worked rather well.
Q Okay. Was -- was the SPS-10 similar in composition or design to the SPS-40?
DEFENSE COUNSEL: Objection; form.
Go ahead, sir.
BY MR. PAUL:
Q If you're able to answer that question.
A I would say they did the same job, as far as a radar system --
Q Okay.
A -- but as being similar, no.

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Q Okay.
DEFENSE COUNSEL: Move to strike on same grounds.
(Plaintiffs' Exhibits 27 and 28 were marked for identification by the court reporter.)
BY MR. PAUL:
Q Well, let me show you what we have previously marked as P-27 and ask if you recognize P-27 and P-28.
A Thank you.
Yeah. Okay. That's the SPS-40.
Q Okay. What kind of work, if any, did you have to do on the SPS-10?
A Personally, I did not work on any of the SPS-10, because that was the radar section.
Q Okay.
A And I was a communications ET.
Q Right.
A Okay?
Q Who -- who was in charge of working on the radar? Can you remember any of the -- any of the names of the guys?
A Yeah. There was two guys who -- who knew this radar.

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Q Okay.
A And I can't remember their names.
Q All right. Does the name Joe Land- -- Joseph Landrum mean anything to you?
A Yeah. Joe worked with me.
Q Okay. What did --
A And he was communications.
Q He was in the communications side, he was not --
A Right.
Q -- the radar side.
Okay. All right. So do you have any knowledge about work that was done on this particular piece of equipment, on the SPS-10?
DEFENSE COUNSEL: Objection; asked and answered.
Go ahead, sir.
THE WITNESS: All I know is, you know, when the -- the 10 wasn't working --
BY MR. PAUL:
Q Right.
A I'm trying to think of the guy's name. I -- I see his face, but that doesn't help anybody.
Q You might think of it later.

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A Yeah.
Q Okay. We'll get to it.
A Whenever it wasn't working, we called --
Q Okay.
A -- whatever his name was and said, you know, "Here." And he -- him and -- and the one other guy who had knowledge of how to work on the 10 would go troubleshoot it.
Q Okay.
A It was basically a -- a good reliable system. The main problem we had with the -- with the radar section was the repeaters, not the radar system itself.
Q What's the difference between a radar -- between a repeater and any other piece of equipment?
A Okay. The radar -- a radar system, okay, whether it's an air search or a surface search, finds out where something is, okay, and it sends it down to a switchboard. This switchboard takes it to a repeater which will -- you've probably seen the rotating indication on all the science fiction things and everything of the -- the sweeps going around on a repeater.

Card Index of Radar Sets - Naval Radars

AN/SPS-40 Surface Search Radar

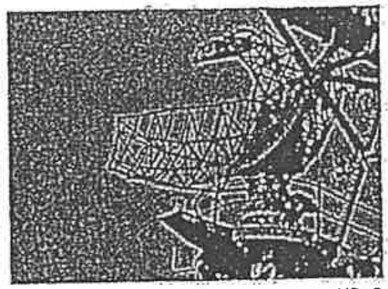

Figure 1: Lightweigt antenna of the AN/SPS-40 on Bord of Lütjens class destroyer (© 2013 www.kriegsschiffe.eu)

Manufacturer: Northrop Grumman Norden Systems

The AN/SPS-40 is the primary shipboard long-range, high-powered, two-dimensional (2D), surface and air search radar for detection of targets at long and medium ranges. It provides 10-channel operation, moving target indicator (mti), pulse compression, and high data short range mode (SRM) for detecting small, low-altitude, close-in targets. The AN/SPS-40B baseline (which includes the B, C and D radars) is designed to provide optimum performance capabilities with minimum operator interface. Special features of the AN/SPS-40B include long-range resolution and accuracy, light weight and flexible packaging for easy shipboard installation, field proven high reliability, maintainability and availability. The UHF(B) band operating frequency provides freedom from weather clutter and low vulnerability to anti-radiation missiles. The system's digital moving target indicator provides excellent subclutter visibility and has solid-state receiver, power supplies and controls. The receivers sensitivity (minimum discernible signal) is −115dBm with a noise figure of 4.2

The antenna reflector is a truncated paraboloid reflector of open lattice work construction, covered with a wire screen to reduce weight and wind resistance. The dual feed includes the primary radar section and an integral identification friend-or-foe antenna. The primary feed is a slot type, it has a tuned cavity and flared shape to ensure proper illumination of the reflector. The reflector then forms the RF energy into a fan shaped beam with a 19° vertical beamwidth and 10.5° horizontal beamwidth. The antenna has a gain of 21 dB at a sidelobe attenuation of 27 dB in azimuth.

The AN/SPS-40 solid-state transmitter is replacing the tetrode tube transmitter of the surveillance radar, and the new version is designated AN/SPS-40E. The nominal 250 KW output of the transmitter is achieved by combining in parallel 112 power amplifier modules arranged in two groups, 56 each. The stripline approach is used in the design of the large output 56:1 combiners. When compared with their tube counterparts, the AN/SPS-40 solid state transmitters provide improved performance and superior reliability, availability, and maintainability. (The older tube version was in practice extremely sensitive to the vibrations caused by the ship's artillery.)

Specifications

frequency:	402.5 to 447.5 MHz UHF-Band
pulse repetition time (PRT):	
pulse repetition frequency (PRF):	ø 257 Hz (staggered) 300 Hz (non-staggered)
pulsewidth (τ):	60 µs (long range mode) 3 µs (short range mode) compressed to 1 µs (or 0.6 µs)
receive time:	
dead time:	
peak power:	200 - 255 kW
average power:	2 kW
instrumented range:	370 km
range resolution:	less than 0.05 NM
accuracy:	
beamwidth:	β=10.5°; ε=19°
hits per scan:	
antenna rotation:	7.5 or 15 rpm (6 rpm in SPS-40 and -40A)
MTBCF:	
MTTR:	

The solid-state transmitter architecture is highly redundant. It is predicted to have a 90 per cent probability of maintenance-free operation for 90 days with no more than 11 per cent projected reduction in radar range performance. The 112 transmitter modules are identical and interchangeable, as also are the power supplies. In the event of component failure, the system undergoes a gradual and graceful degradation in transmitter output. It remains fully operational and capable of detecting targets. The transmitter solid-state technology offers inherent tactical flexibility. For example, output power is adjustable. As a result, ships can reduce their susceptibility to detection while maintaining substantial air surveillance capability. If the tactical situation requires emission control conditions, the solid-state transmitter will respond instantly. Similarly the transmitter will immediately radiate at full power with just the touch of a push-button. Pulse-to-pulse frequency diversity is also provided. A unique automatic levelling control system greatly reduces the need for maintenance actions. This system automatically senses and compensates for degradations in transmitter module performance.

The AN/SPS-40 is operational e.g. on Bangladesh Navy's ship *Somudra Joy* (Hamilton-class). The most AN/SPS-40 radars are replaced by AN/SPS-49(V) radars in the late 1980s and early 1990s.

Versions and improvements:

- AN/SPS-40: Basic version, manufactured by Lockheed/Martin;
- AN/SPS-40A: slightly modified variant, manufactured by Sperry;
- AN/SPS-40B: including a secondary radar; a total of 43 radars were produced by Norden Systems;
- AN/SPS-40C: Improved detection of low altitude flying targets, advanced EPM capabilities;
- AN/SPS-40D: modified 40A version with higher reliability, including a coupling equipment for the AN/SYS-1 system; manufactured by Westinghouse.
- AN/SPS-40E: manufactured by Norden Systems, includes the solid-state transmitter (described above)

Sources: Technical Manual, AN/SPS-40 Radar Set, NAVSEA 0967-LP-441-9010 and NAVSEA Drawing RE-D2699234

PLF/DEFT EXHIBIT NO. 6 FOR
DATE 8-20-19 PAGES 2
WITNESS Gossett
DEBRA-LYNN BAKER, CSR NO. 8700

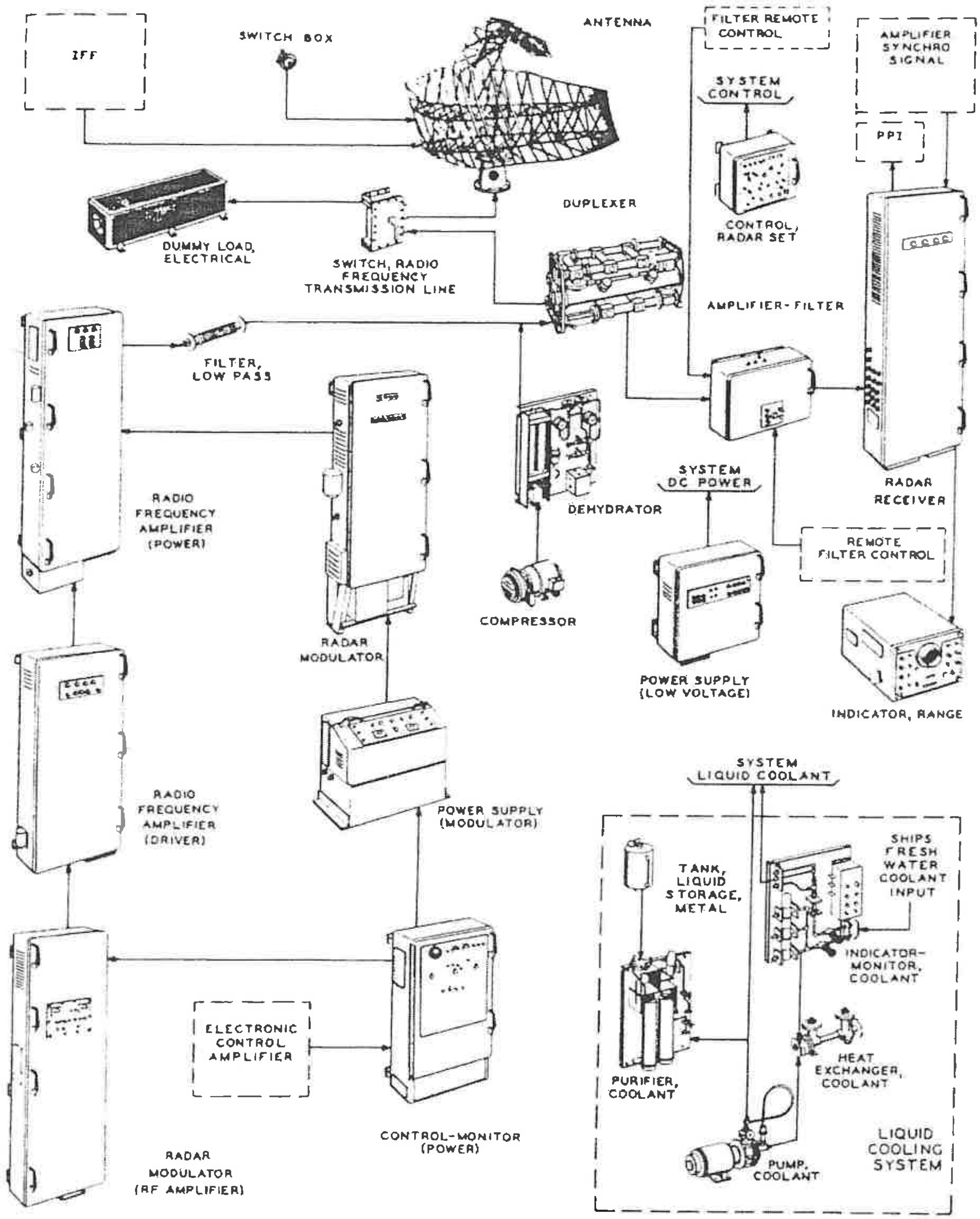

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Figure 6-4.—Air-search Radar Set AN/SPS-40 system.

EXHIBIT F

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF PENNSYLVANIA

ROBERT J. KRAUS PLAINTIFF

VERSUS NO. 18-2119

ALCATEL-LUCENT, ET AL. DEFENDANTS

****

DEPOSITION
OF
JOE R. LANDRUM

****

(APPEARANCES NOTED HEREIN)

DEPOSITION TAKEN AT THE INSTANCE OF
THE PLAINTIFF
IN THE MEETING ROOM OF HOLIDAY INN EXPRESS & SUITES,
TUPELO, MISSISSIPPI,
ON TUESDAY, AUGUST 13, 2019,
COMMENCING AT 9:01 A.M.

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A. No. You can walk right up and touch it.
Q. Okay. Well, that's when it's not being used. When it's being used, can you walk up to it and touch it?
A. Sure.
Q. You can?
A. Right.
Q. Even then, okay.
A. Yeah. Everything that's going on is going on on the inside.
It's just like handling a coaxial cable.
Q. Okay. All right. Any other pieces of equipment that you worked on at the -- in the shop?
A. Well, I was a radar technician, but the -- the -- the two branches, radar and communication, sort of bleed over, so you end up working on everything, especially if you're a Radar Technician.
Radar Technicians work on more communication than communication people work on radar because there is more communication on a ship.
Q. Okay.
A. There's lots and lots of it.
Q. Okay. Any other particular pieces of equipment that you mentioned?
A. Loran, fathometer.

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Q. Okay.
A. I think that's about it.
Q. All right. You mentioned -- are there any other pieces of equipment -- you're welcome to take a look at your notes again.
Are there any other pieces of equipment that you wrote me about that you haven't talked about so far?
A. I don't think we've talked about the SPS-40.
Q. Okay. Let's talk about the SPS-40. Where was the SPS-40?
A. That was forward of the superstructure. It's an air search radar. The antenna would be noticeably larger than the surface search. The SPS-40 was an air search without height-finding capabilities. So it just told us where the aircraft were.
MR. SMITH: Can I have the answer read back, please?
Move to strike nonresponsive portions.
THE REPORTER: Oh, I'm sorry.
MR. SMITH: Question and answer.
MR. PAUL: Can we go off the video while she's doing that?
THE VIDEOGRAPHER: Off the record. The

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time is 9:58 a.m.
(Off the record.)
(Previous question and answer played back.)
THE VIDEOGRAPHER: Back on the record. The time is 10:00 a.m.
BY MR. PAUL:
Q. All right. I've shown you what is -- can you tell us what P6 is?
A. Yeah. This is a picture and description of the SPS-40 radar.
Q. Okay. Now, the SPS-40 that was on the Cambria in '64 to '65, that was -- was called the SPS-40 and wasn't an A, a B, a C, a D?
A. Not that I recall, no.
Q. Okay. It was just the straight SPS-40?
A. Right.
Q. Do you have any recollection of who made that product?
A. No.
Q. Did you ever -- recall ever seeing anybody from the company that made it in the shop or in the --
A. No.
Q. When it was in the -- when you were at the Navy yard, do you recall seeing anything about that?
A. No.

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Q. Where was the -- we started to ask about where the SPS-40 was, and you started to tell me. Can I ask it again so I --
A. Yeah. It's forward of the superstructure that was -- what would look to you like a mast. It was actually a king post. And the -- the 40 itself, the radar itself was located at the base of this mast, and the antenna was located directly above it.
Q. Did any part of the SPS-40 that was somewhere else in the -- in the ship --
A. Well, the 40 repeaters -- let me start over again.
The SPA-8 repeater was used for both the 40 and the 10. You could switch back and forth from air search to surface search.
Q. Okay.
A. But as far as a part of the radar itself, no, it was contained in a little compartment at the based of that king post.
Q. Okay. Was a piece of the SPS-40 in your shop?
A. I don't think so. I take that back. There was a piece of WaveGuide --
Q. Okay.
A. -- that rattled around for a while.

that suggest to you they they're true and accurate records of what the Navy was doing at the Philadelphia Navy yard?
A. I would expect they would be accurate.
THE DEFENDANTS: Objection to form. Foundation.
THE DEFENDANTS: Objection. Move to strike. Can't establish foundation for this witness.
BY MR. PAUL:
Q. Now, you were not present through the entire repair in Philadelphia, correct?
A. That's correct.
Q. Okay. You -- you got sent to another ship?
A. Right.
Q. Okay. And which ship was that?
A. I was assigned to a -- to a ship that was, in turn, assigned to the Columbian Navy. So I spent about six months aboard a Columbian ship.
Q. Okay. So over the time that you and Bob Kraus were on the ship, are you able to -- to -- in any way to tell -- tell us how often he was in the presence of you or one of other guys doing the repair work that you've described so far?
THE DEFENDANTS: Objection. Calls for

speculation.
A. Yeah. I can't -- can't give you a figure on how many times.
BY MR. PAUL:
Q. But, in fact, he was technically in charge --
A. Right.
Q. -- of the activities of you guys?
A. He was.
Q. Were responsi- -- and so he was responsible for reporting to the captain what you guys were doing?
A. That's correct.
Q. All right. Okay. You've seen the chart that he prepared?
A. I have.
Q. Okay. Did that have any -- would that refresh your recollection in any way about the equipment that was on the ship?
A. You know, mostly what it did was it showed me that I had it right.
Q. Okay.
A. You know, I referred to the SPS-10, SPS-40, SPA-8, SPA-4.
Q. Right.
A. And then that -- that appeared on his list.

I was kind of -- kind of tickled myself, I got it right after all those years.
Q. Okay. And you don't know how he prepared that list or --
A. I have no idea.
Q. All right. All right. And, sir, so you've told us everything that you can tell us about what you remember about being with Bob and what he did on the ship and what you did on the ship?
A. Everything that concerns electronics.
Q. All right.
A. We left out the sea stories and --
Q. Well, we'll leave the sea stories out. But let's just talk about the work stuff.
But as far as the work history, you've described pretty much what you did and what he was in charge of seeing was accomplished on the ship?
A. That's correct.
Q. All right. And that was his job to make sure that -- that you guys were accomplishing the tasks that you've described to us?
A. Right.
MR. PAUL: All right. Thank you. Cross-examine?
Let's go off the video.

THE VIDEOGRAPHER: Off the record. The time is 10:24 a.m.
(Off the record.)
THE VIDEOGRAPHER: We're back on the record. The time is 10:43 a.m.
EXAMINATION
BY MR. SMITH:
Q. How are you doing, Mr. Landrum?
A. Fine.
Q. I'm Michael Smith. I'm here on behalf of Lockheed Martin Corporation and Space Systems/Loral, LLC.
A. Okay.
Q. I just want to start off. I want to mark as Exhibit D1 the notice of Mr. Landrum's deposition.
(WHEREUPON DEPOSITION EXHIBIT NO. D-1 WAS MARKED AND A COPY IS ATTACHED HERETO.)
MR. SMITH: Can we go off the record for a second?
THE VIDEOGRAPHER: Off the record. The time is 10:44 a.m.
(Off the record.)
THE VIDEOGRAPHER: Back on the record. The time is 10:45 a.m.
BY MR. SMITH:

EXHIBIT G

ENCLOSURE I

ENCLOSURE I

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

IN REPLY REFER TO
Ser 4542/318054
5 Jan 1979

Mr. Robert F. Hughes
Assistant Director
U. S. General Accounting Office
Human Resources Division
Washington, D. C. 20548

Dear Mr. Hughes,

This is in response to your letter of October 5th in which you requested information on the extent to which asbestos is being used in the Navy's shipbuilding and ship repairing operations. This response reflects our understanding of the scope/detail of your request as amplified by Mr. Joseph Daigle of your staff during a meeting in late October.

In response to questions 1, 2 and 4, attachment #1 provides a listing of U. S. Navy ships (class, name and hull number) which were delivered since 1973 or are under construction and also provides information regarding the status of thermal insulation. Each ship has several types of asbestos containing materials installed; however, thermal insulation for machinery, equipment and piping systems has been the major application of asbestos.

Even though the use of asbestos as thermal insulation has been eliminated, there remain a few shipboard applications where technically acceptable substitute asbestos-free materials have not yet been identified. Therefore, all ships presently in service contain some quantity of asbestos.

Asbestos fibers are incorporated in the plastic-like body of certain electrical resistors found in home, TV and stereo equipment and in Navy electronic equipment. Asbestos is used in home and office floor tiling and on Navy ship decks. Asbestos is used on electric cabling found in many commercial ovens, home hot water heaters and in Navy galley ranges. Piping system gaskets and packing used throughout thousands of American industries and homes and in Navy shipboard piping systems contain asbestos. Asbestos is used in automotive brakes and clutches and in Navy ship equipment brakes and clutches. The list is nearly endless. There are so many common uses of asbestos that it is nearly impossible to build a Navy ship free of the mineral.

ENCLOSURE I

In regard to question #3, data concerning the amount of asbestos used as thermal insulation in Navy ships is obtainable by search of weight control reports for individual ships. The USS PAUL F. FOSTER (DD-964) contains 87,634 pounds of thermal insulation. The quantity of thermal insulation used on the remaining classes of ships (CCNs, SSNs, YTBs, YONs, AORs and AGORs) listed in Attachment #1 as having asbestos thermal insulation will be provided not later than 15 January 1979. It must be pointed out that this information will be the weight of thermal insulation installed and will not include the amount of asbestos used in other applications, such as pipe hanger liners, gaskets, etc.

You also asked why non-asbestos materials could not be used for thermal insulation in all ships delivered since 1973. Shipbuilding is an enormously complex task. For large ships, it takes 10 or more years from conceptual design to deliver the first of a class. The design of systems and components, the assemblage of materials, contract placement, work scheduling, hiring and training of workers and many other complex aspects must be carefully coordinated. When such a basic, fundamental change as switching from asbestos insulation to fiberglass insulation is made, all these aspects are affected. It is simply not possible to change, in an instant, from asbestos insulation to non-asbestos insulation throughout the Navy fleet. Decisions to replace asbestos thermal insulation with non-asbestos materials had to be made on an individual ship or ship class basis, considering the state of ship construction completion and the cost and schedule delay associated with the change. Likewise, it was necessary to negotiate contract modifications with each shipbuilder to eliminate the installation of asbestos. In some cases, the Navy was successful well before 1973-74. For example, the Navy approved use of asbestos-free materials in CVN 68 class propulsion plants in 1971 and in the last two SSN 637 class submarine propulsion plants in 1972. For other ships, such as the first eleven of our new DD 963 class ships, the change was not accomplished until later. Consequently, ships well under construction and already insulated at that time continued through to delivery as late as May 1978 with asbestos insulation. Consequently, some ships were delivered with asbestos thermal insulation since 1973.

ENCLOSURE I

Additionally, I must correct your apparent misconception of the importance of the 1973-74 date. The Navy usually procures materials for ship construction, including thermal insulation, in accordance with product specifications. These documents describe, for the supplier, the product the Navy wants. In the case of insulation specifications, changes were made as early as 1971 to specify that the Navy wanted materials with little or no asbestos. By late 1973, these specifications had been changed to call for asbestos-free materials. The fact, however, that these product specifications were changed to call for asbestos-free materials does not mean that shipbuilders must stop using asbestos products. Many ship-sets of asbestos containing products, purchased to earlier versions of the product specification had already been bought and in some cases installed. Tens of thousands of pounds of asbestos products remained in warehouses, aboard ships, and in shipyards, in active use. With no positive action by the Navy, many additional years would pass before the asbestos products were exhausted. Although, in some cases, separate action by some Navy components resulted in asbestos-free products being used prior to 1973 or 1974, the overall Navy policy prohibiting the use of such material could not be promulgated until we had some assurance that it could be followed. By 1975, asbestos-free materials were generally available to all Navy agencies and the no-asbestos policy statement, NAVSEAINST 5100.2 of 24 October 1975 issued. I hope this clarifies this important point.

In regard to question #5, non-asbestos materials approved by the Department of the Navy for use as thermal insulation on naval ships include calcium silicate (with non-asbestos fillers), fibrous glass, refractory felt (alumina/silica), elastomeric foam and cellular glass. While all types are currently being used, fibrous glass and calcium silicate are the two principal asbestos replacement materials for thermal insulation.

In response to question #6, cost data for reinsulating some types of ships with non-asbestos materials have been developed and are as follows:

ENCLOSURE I

ENCLOSURE I

CLASS	EST. COST PER SHIP (Million)	ACTIVE SHIPS	TOTAL EST. COST (Million)
FRIGATE:			
FF-1037	$2.75	2	$ 5.50
FF-1040	2.75	10	27.50
FF-1052	4.32	45	194.40
DESTROYER:			
DD & DDG	5.37	65	349.05
SUBMARINE:			
SSN-578	1.62	4	6.48
SSN-594/637	3.90	57	222.30
SSBN	3.90	41	159.90
Total		224	$965.13

These estimates are for the removal of asbestos thermal insulation from piping, equipment and ventilation ducting, excluding nuclear equipment components, and reinsulation with non-asbestos material. These estimates do not include asbestos removal/replacement in applications other than thermal insulation, and do not include the whole fleet, only about half of it. Furthermore, these cost estimates are tentative and have not been validated. It is anticipated that return cost data for total thermal reinsulation obtained from three ships, will be available in February 1979. These tentative estimates and return cost data mentioned above can be extrapolated to obtain a cost estimate to reinsulate the entire fleet.

Regarding removal of all asbestos aboard Naval vessels, Navy policy has required replacement of asbestos insulation with substitute material when insulated equipment and machinery are repaired. Recently, this policy has been modified to require, in addition, selective replacement of asbestos insulation in those high-maintenance areas where repairs may be anticipated during the subsequent operating cycle of the vessel. During the next five years, implementation of this policy will result in the removal of all shipboard thermal asbestos except that 30 to 50 percent which is normally untouched during the life of the ship.

ENCLOSURE I

The concept of one-time total asbestos removal on all ships has been under intensive review to determine if such a policy revision is technically and economically feasible. Initial analysis does not justify such a policy change. While there is no intention to conduct a trade-off of human health for maintenance and repair funds, the funds involved are substantial. As indicated above, the estimated cost to reinsulate just three classes of ships (frigates, destroyers, and submarines) is $965.13 million. It is reasonable to assume that the estimated cost for total asbestos replacement in all ships will approach two billion dollars. The true cost is likely to increase significantly because of delay and disruption effects, increased overhead charges due to longer overhauls, and increased shipyard manning to handle the added work.

This enormous cost is not the only reason that the Navy has not adopted a one-time total asbestos removal policy. Other factors which support the present policy are the following:

a. During the life of a ship, 30 to 50 percent of the total asbestos insulation will never be touched except for painting or making minor repairs to the lagging cover material. Measurements show that operating ships equipped with asbestos insulation have airborne asbestos levels at or below 0.1 fibers per cubic centimeter. This value is comparable to the ambient level reported for the City of Philadelphia by Dr. Irving Selikoff, a well known asbestos expert. Therefore, on the basis of existing information, a properly maintained and operating ship should not present an active asbestos hazard.

b. The Navy requires and enforces stringent asbestos work standards which control exposure of workers to asbestos dust during ship repair. By minimizing the amount of asbestos work done, the potential exposure, residual dust, and overhaul cost are minimized.

c. Fibrous glass and calcium silicate products are being used as asbestos replacements. The National Institute for Occupational Safety and Health has recommended controls for fibrous glass work that are nearly identical to the controls now imposed for asbestos work. It seems reasonable to assume that if the Institute recommends nearly identical controls for two similar substances, comparable hazards could be known or suspected. Therefore, it is not at all certain that wholesale replacement of asbestos products gains any medical advantage at all.

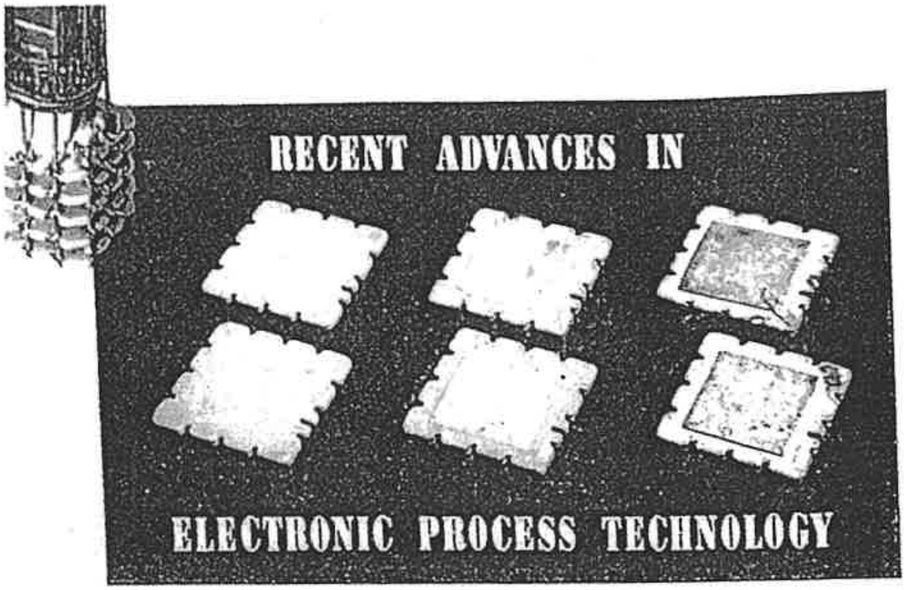
ENCLOSURE I

d. Despite the enormous cost, replacement of asbestos thermal insulation in ships will not eliminate asbestos exposure of civilian and military Navy personnel. According to the National Institute for Occupational Safety and Health, asbestos dust is everywhere. Low but easily measurable levels of airborne asbestos dust are found in the air of cities throughout the country, much of it generated by automotive brake and clutch linings. Asbestos is used in so many products that most of the U. S. populace unknowingly encounters it daily.

I hope this information satisfactorily answers your inquiry regarding the extent to which asbestos is being used in the Navy's shipbuilding and ship repairing operation.

Sincerely,

T. J. B[illegible]
Vice Admiral, U.S. [illegible]
Deputy Ch[illegible] of [illegible]
Operations [illegible]



MDE–MPE tape capacitors in stages of production. Wafers at left are cured steatite blanks of same general type used in MDE–MPE system. Silver pattern that forms one electrode of capacitor has been applied to two wafers in the center. In wafers at right, adhesive dielectric-coated tape is cut into squares slightly larger than the silver contact and then pressed down onto the wafers. After curing, the capacitor is ready to be assembled into a module with other wafers such as that shown at top left.

SINCE the announcement of a new system for the mechanized production of electronics in 1953, the National Bureau of Standards has developed additional compatible components and techniques under the sponsorship of the Navy Bureau of Aeronautics. Recent advances achieved by NBS in electronic process technology include an adhesive tape capacitor, a "chip" resistor, and a method for applying pyrolytic carbon resistors. Developed by B. L. Davis of the Bureau's process technology laboratory, these components and techniques should do much to increase the versatility and applicability of electronic equipment manufactured by automatic production lines.

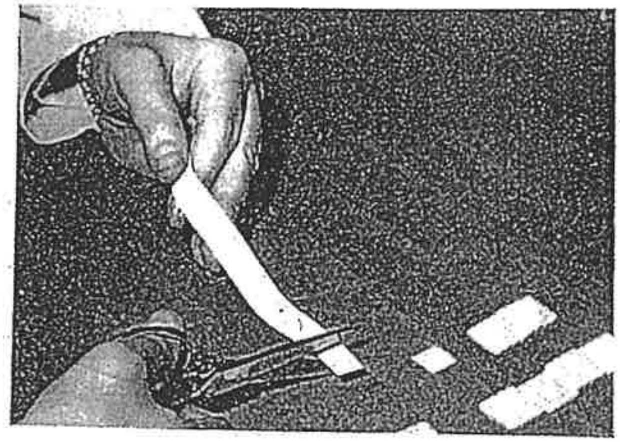
The development of systems for Modular Design of Electronics and Mechanized Production of Electronics (MDE–MPE), formerly code-named Project Tinkertoy, was begun by the Bureau with the cooperation of several industrial companies under the sponsorship of the Navy Bureau of Aeronautics as an industrial preparedness measure. The MDE–MPE system starts with raw or semiprocessed materials and automatically manufactures ceramic base wafers, dielectric elements for capacitors and adhesive tape resistors; prints conducting circuits and capacitors; and mounts resistors, capacitors and other component parts on standard, uniform steatite wafers. The wafers are stacked like building blocks to form modules that perform all the functions of one or more electronic stages. The pilot plant, operated by a commercial contractor, incorporates the principles of this system. The plant was designed to produce 1,000 finished and inspected modules per hour.

The Tape Capacitor

The self-adhesive tape capacitor is designed specifically for application to the ceramic wafer by MDE–MPE machine techniques. It is manufactured in much the same manner as the NBS adhesive-tape resistor.[1] A conducting tape, coated on one side with a dielectric, provides one element of the capacitor. The other element is a silver pattern printed and fired on the wafer. It is now possible to apply an adhesive-tape

In this chamber electrically conducting solution is sprayed on one side of tape, dried, and then sprayed on other side. When cured, dielectric formulation is sprayed on one side of tape. It is then ready to be used as one element of the capacitor. Spray unit can be seen at far right.

Application of adhesive tape capacitor to wafer. Although shown here as a manual operation for demonstration purposes, it is normally applied by machine.



resistor to one side of a wafer and an adhesive-tape capacitor to the other side.

The materials required for the manufacture of tape capacitors are a heat-resisting asbestos paper tape, silver flake, silicone resin, butyl cellosolve, a powdered high-K titanate body, *n*-hexane, and epoxide resin. The electrically-conducting formulation (a mixture of the silver flake, silicone resin, and solvent) is ground in a ball mill. The mixture is sprayed on a loop of tape 1¼ in. wide, allowed to dry thoroughly, and then sprayed on the other side. When cured, the metallized tape is conductive along each side and from one side to the other. After slitting along the center to form two ⅝-in tapes, it is ready for application to the dielectric film. A roll of tape 19 ft long will produce about 350 capacitors.

The dielectric formulation is composed of high-K titanate body that has been pulverized in a ball mill with *n*-hexane until the particle size is about 1 to 2 microns, after which the slurry is allowed to evaporate under a hood. The ground titanate body is mixed with epoxide resin and further ball-milled. This tacky dielectric mixture is then sprayed on the metallized base tape in various thicknesses determined by the number of passes the tape makes in front of the spray gun. Thicker applications, of course, make capacitors of lower value.

The silver pattern that forms one electrode of the capacitor is applied to the steatite wafer by means of a screen press. It is then dried and fired onto the ceramic. The adhesive dielectric-coated tape that forms the other electrode is cut into squares slightly larger than the silver contact and pressed down on it. A narrow conductive strip, similar to resistor tape but with a conductivity of approximately 0.02 ohm per half inch, is laid down between a contact on the edge of the wafer and the top side of the capacitor. The complete assembly is then cured by placing it in a oven at room temperature, raising it to 225° C over period of one-half hour, and holding the temperatur at 225° C for 45 minutes.

Capacitors of higher values can be manufacture by applying a number of layers of tape, one on to of another, with appropriate connections to the edg of the wafer. Smaller capacitors can be made by reducing the area of the silver pattern printed on the wafer, or by increasing the thickness of the dielectric layer. For typical values, see table 1.

Second element of capacitor is a silver pattern printed on an MDE-MPE wafer. Elements may be printed on either or both sides, depending on requirements of finished circuit. An adhesive tape resistor can be applied to opposite side of wafer instead of a capacitor, if desired.

Shelf life tests indicate that the capacitance changes no more than 1 percent during the first month after manufacture, and that there is no change in the dissipation factor, which averages 0.7 percent at 1 kc. However, the capacitance does change somewhat with temperature, −3 percent from 25° to 85° C, and −15 percent from 25° to −55° C. In a load life test, a few capacitors shorted out, but otherwise only negligible changes occurred in capacitance and dissipation factor.

The "Chip" Resistor

The "chip" resistor is made by applying self-adhesive resistor tape to a small chip of ceramic material. This resistor is not for use in the regular quantity production of modules, but aids the electronic design engineer in studying new modular circuits which are still in the "breadboard" stage or in producing prototype equipments for evaluation. The chip is inserted into a circuit simply by soldering it to the appropriate connections on a standard wafer.

The precured resistor tape is manufactured automatically by the usual MDE–MPE techniques but is applied to a chip of cured steatite about 0.600 by 0.225 in. instead of the standard MDE–MPE wafer. A prototype machine developed in the NBS laboratories

of a highly accurate gas thermometer for this purpose requires painstaking and time-consuming precision, the work on the secondary thermometer is being pursued concurrently. Resistance thermometers constructed of the semiconducting elements, silicon and germanium, have proved to be extremely sensitive; in some cases the resistance changes more than 50 percent per degree. While satisfactory reproducibility still remains a problem, results of initial tests have been quite promising.

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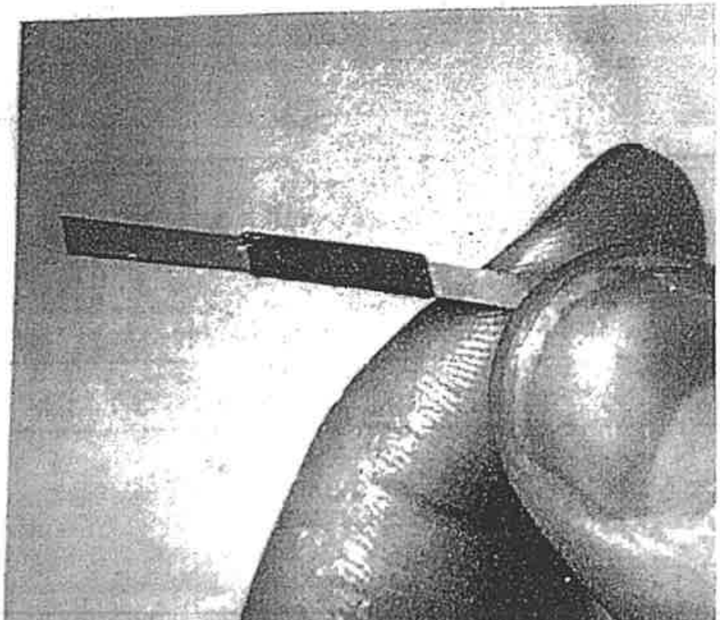
NBS Precured Tape Resistor

THE ADHESIVE-TAPE resistor developed by the Bureau has aroused wide interest since its announcement in 1951.[1] In the NBS tape-resistor system, designed primarily for electronic printed-circuit applications, small pieces of self-adhesive resistance-coated tape are simply pressed into place against metallic terminals at the proper points in the circuit. The resistor was developed as part of a program of miniaturization of airborne equipment sponsored by the Navy Bureau of Aeronautics. Despite its advantages, the method has been limited in some applications by the necessity for baking the supporting base material to cure the resistors after they have been pressed in place.

A new precured wire-lead version of the tape resistor, now being made at NBS, obviates the need for heat-curing after placement in the circuit. The new resistors are made by pressing uncured resistor tape against both sides of suitable wire or metal-ribbon leads; the leads are thus sandwiched between two pieces of resistor tape. These units are then given the usual heat cure, which bonds the resistor tape to the

[1] A high-temperature adhesive tape resistor, *NBS Tech. News Bull.* **35**, *100 (July 1951). Described in detail in* An adhesive tape resistor system, *NBS Circular 530, Government Printing Office, 30¢.*



Left: the recently developed precured version of the Bureau's tape resistor can be soldered or spot-welded into the circuit. The original version of the NBS tape resistor is self-adhesive, but must be heat-cured by baking the chassis after all resistors have been pressed in place. The precured resistor is made by sandwiching suitable metal leads between two uncured resistors and then heat-curing, which bonds the resistor to the leads. Over-all length is about 1½ inches. *Right:* soldering one of the precured NBS tape resistors into place. Because no subsequent heat-curing is needed, this version of the tape resistor can be used with chassis that would not withstand curing temperatures (about 300° C.).

leads and results in resistors that may be soldered or spot-welded into the circuit.

With the new precured variation in addition to the basic press-on form, the range of possible applications of the NBS tape resistor is greatly extended. Characteristic advantages of the NBS tape resistor—compactness, stability, and high-temperature operation—are largely retained in the precured wire-lead design. Furthermore, the new resistor might well prove more economical to manufacture in quantity than other types having less desirable characteristics.

The basic NBS tape resistor is made by coating asbestos-paper tape with a mixture of carbon black or graphite, silicone resin, and solvent. Resistor dimensions are standardized at one-half inch long and about one-eighth inch wide; a variety of coating formulations have been developed to give a wide range of resistor values.

Leads for the precured tape resistor are now being made from ribbon of thin silver or silver-plated copper at NBS. Leads extending one-half inch beyond the resistor proper are used, bringing the over-all length to 1½ inches. Thickness is held to about 0.012 to 0.015 inch.

Preliminary tests indicate that the precured NBS tape resistor, when supported in air by its leads alone, will not provide the full dissipation of 0.25 watt at 200° C for which the basic resistor was designed. Further test work is now in progress, and a suitable derating curve will be worked out.

New NBS Director Appointed

DR. ALLEN V. ASTIN has been appointed* Director of the National Bureau of Standards. Formerly Associate Director of the Bureau, Dr. Astin has been Acting Director since October 1951. Dr. Astin has also been appointed a member of the National Advisory Committee for Aeronautics.

Dr. Astin has been a member of the Bureau's staff since 1932. Until 1940 he was principally concerned with dielectrics and electronics. His contributions include development of improved methods for precise measurement of dielectric constants and power factors of dielectric materials and studies of the nature of energy losses in air capacitors. He did pioneering work in the development of radio telemetering techniques and instruments and applied this work to studies of cosmic rays and of meteorological problems in the earth's upper atmosphere.

In 1940 Dr. Astin was one of the Bureau scientists doing pioneering work in proximity fuze research and development for bombs and rockets. He became chief of the Optical Fuze Section in 1943, assistant chief of the Ordnance Development Division in November 1943, and chief of the Division in July 1948. He played a major part in the development and evaluation of bar-type proximity bomb fuzes and in their introduction to service during the war. During the fall and winter of 1944–45 he served in Europe as representative of the Bureau and consultant for the Ordnance Accessories Division of the National Defense Research Committee, concentrating on proximity fuze problems. He edited the terminal three-volume Technical Report of the Ordnance Accessories Division (Division 4).

As chief of the Ordnance Division from 1948 to 1950, he supervised the Ordnance Laboratory, the Guided Missile Laboratories, and the Electronics and Tube Laboratories. When Dr. Astin was appointed Associate Director in May 1950, he assumed responsibility for the work of the Ordnance Development, Missile Development, Electricity, and Electronics Divisions as well as the Office of Basic Instrumentation.

Dr. Astin was born in Salt Lake City, Utah, on June 12, 1904. He received the B. S. degree in physics from the University of Utah in 1925. While working toward his advanced degrees at New York University from 1925 to 1928, he was a graduate assistant and instructor in physics. From N. Y. U. he obtained the M. S. and Ph.D. degrees in physics in 1926 and 1928 respectively. From 1928 to 1930 he held a National Research Council Fellowship at Johns Hopkins University, doing basic research on measurement techniques relating to dielectric materials. Between 1930 and 1932, he was a Research Associate in a program sponsored at the Bureau by the National Research Council and the Utilities Research Commission, Inc.

Honors and awards he has received include the following: National Research Council Fellow in Physics, 1928–1930; Navy Ordnance Award for Exceptional

Dr. Allen V. Astin

Patented Aug. 6, 1935

2,010,133

UNITED STATES PATENT OFFICE

2,010,133

RESISTOR

Sidney Bloomenthal, Merchantville, N. J., assignor to Radio Corporation of America, a corporation of Delaware

No Drawing. Application November 25, 1933, Serial No. 699,707

16 Claims. (Cl. 201—76)

My invention relates to resistors and more particularly to resistors of types suitable for use in radio receivers, wherein noise occasioned by variations in resistance during the passage of current therethrough must be minimum.

Resistors of types used in radio receivers must be "quiet". That is to say, since such resistors are usually utilized in connection with sensitive thermionic devices, their resistance must not fluctuate while they are conducting electric currents. This requirement must be met to a greater or less degree in the manufacture of all resistors of the types under discussion.

A resistor for use in radio receivers should also have a substantially zero temperature coefficient of resistance and a low load-coefficient of resistivity. That is to say, it should be so made that temperature changes occasioned either by atmospheric conditions or by the passage of electric current therethrough will not materially affect the resistance value.

It is, accordingly, an object of my invention to provide a new and improved resistor that shall be substantially free from noise when used in an amplifier.

Another object of my invention is to provide a resistor that shall have a substantially zero temperature coefficient of resistance during normal operation thereof.

Another object of my invention is to provide a resistor that shall have a low load-coefficient of resistivity.

It is also highly desirable that manufacturing methods be devised and materials provided whereby quantity production of resistors having accurately predetermined values may be had. It is, accordingly, a further object of my invention to provide such methods and such material.

A still further object of my invention is to provide a new resistor material capable of being molded into any desired shape with full assurance that the resulting device will have the predetermined resistance and temperature coefficient characteristics.

The foregoing objects and other objects ancillary thereto I prefer to accomplish, in short, by first coating particles of a filler material, such as asbestos, powdered glass, sand, or the like, or a mixture of filler materials, with a polymerizable resin in solution and thereafter causing conducting material, preferably graphite and/or carbon black, to be precipitated upon the coated particles from a colloidal solution thereof.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment.

Substantially all fixed resistors used in radio receivers, amplifiers, and the like, include a filler, a conducting material, a binder, and a moisture-repellent impregnating material. The electrical and mechanical properties of the resistor depend not only upon the nature of these components but on the manner in which they are put together.

Previous to my present invention, I made many experiments in the effort to utilize asbestos, glass, or sand singly as well as various mixtures of sand or glass and asbestos, as fillers. For a binding material, I tried many grades of phenol formaldehyde resin in liquid and powdered form or in the form of varnish. For the conducting material, I tried dry graphite and carbon black, but in all of my early experiments I found that, if the conducting material was first mixed with the filler and the binder thereafter added, the resistors made from such a compound were extremely variable in resistance value and could not accurately be reproduced by factory processes.

According to my invention, therefore, I first take a predetermined amount of finely ground glass and air floated asbestos and intimately mix with it a solution of phenol formaldehyde resin (known as bakelite) in acetone. The principal function of the ground glass is to impart to the finished resistor a rough surface to which paint and sprayed metallic terminals will firmly adhere. For the mixing process, I prefer to use a device commercially known as a "kneader" and continue the kneading process until substantially all of the solution is evaporated. At this stage in the process, the mass of material has a dough-like consistency and if a small portion of it is examined under a microscope, it will be apparent that every particle of the asbestos and glass is covered with a film of unpolymerized resin left by the evaporation of the acetone.

The "mix" is next removed from the kneader and is crumbled into particles which are allowed to stand until all of the solution evaporates and it becomes quite hard and brittle. The material is next placed in a ball mill, or grinder of any convenient type, and is ground until substantially all of it becomes fine enough to pass an 80 mesh screen.

While the process of grinding is being carried

on, the conducting material may well be in course of preparation. For this material, I prefer to use a colloidal suspension of carbon in water, such as the graphitic material known to the trade as "Aquadag", manufactured by the Acheson Graphite Company, a gas-carbon suspension known as "Aquablack", manufactured by Binney & Smith Company, or a suitable mixture of the two.

In view of the fact that graphite has approximately one-tenth the resistance of carbon, such as is utilized in the manufacture of aquablack, these two commercial materials cannot be interchangeably utilized in the same proportions. It is, however, desirable to use aquadag for resistor elements having relatively low resistance and aquablack or mixtures of the two suspensions, suitably diluted, for resistors having relatively high resistance.

For resistors having high resistance values, it is particularly desirable to use mixtures of graphite and carbon black made from natural gas. If graphite alone is used for such resistors, the proportion thereof is so small that the particles are quite widely separated. This condition gives rise to noise which is obviated by the presence of carbon black particles that effectively "bridge" the graphite particles.

The 80-mesh resin coated particles are next intimately mixed with the colloidal carbon suspension, which has been diluted with water to a point whereat the liquid is substantially 1% carbon by weight, by a stirring operation and, for this purpose, mixing apparatus of substantially any well known commercial type may be utilized.

For the purpose of explanation of the foregoing paragraph, it is to be understood that the term "colloidal carbon suspension" is intended to include diluted aquadag, diluted aquablack, or a diluted mixture of the two. It is also within the scope of my invention to first mix the resin coated particles with either one or the other of the first-mentioned solutions, and to thereafter mix or add the other solution, thus causing successive precipitation of carbon in different forms on the particles.

Under usual conditions of manufacture, the introduction of the resin-coated filler material into the colloidal carbon suspension disturbs the electric charge relations existing in the said suspension, with the result that the carbon is precipitated onto the filler material and forms a conductive film over the entire surface of each minute particle thereof. Under certain conditions the colloidal suspension of the carbon persists and, in such case, I find it advisable to add to the mixture a small amount of hydrochloric acid which coagulates it and causes the precipitation hereinbefore mentioned. As an alternative, for the purpose of coagulating the colloidal suspension, I may add to the acetone solution of the resin, before coating the filler particles therewith, a small amount of furfural or of some other volatile material such as acetic acid, having an ionizable hydrogen atom with which it readily parts. For this purpose, I have also obtained fairly good results with small quantities of an organic acid such as malic, citric, tartaric, or the like.

After the carbon is precipitated onto the filler material particles, the supernatant liquid is either drained off or the solution is filtered in a filter press or the like. The cake resulting from the filtering process is dried at a temperature of approximately 40° C., for 24 hours, or, at least, for a period of time sufficient to drive off substantially all of the residual moisture.

In order that the continuity of the carbon film on the filler particles shall not be interrupted, the dried cake must be handled rather carefully. In other words, it is highly inadvisable to subject the cake to any further grinding operations to prepare it for handling, and at this point in the process it is found best to manually crumble the cake into small particles suitable for charging a molding machine.

The crumbled material is next loaded into the hopper of an automatic "pill" making machine, such as is used in the drug industry, or into equivalent well-known apparatus, which forms it into cylindrical rods under a pressure of the order of ten tons per square inch. For the sake of uniformity, I prefer to form rods ¾" in length and ¼" in diameter if the power rating thereof is not to be in excess of one watt. The rods made as described are then placed in trays and baked in an oven at 170° C. for approximately one hour.

I am not, at this time, prepared to exactly explain all of the physical changes caused in the pill by the baking process and consequent polymerization of the resin coating underlying the carbon on each particle of filler.

It appears, however, that during the baking step of the process, the carbon films on the particles merge together to provide what might be termed a "honeycomb" structure, of conducting material, and that the polymerization of the binder serves to lock the elements of the said honeycomb structure firmly in place, without disturbing the continuity of the carbon contacts. However, in view of the fact that the carbon films are extremely thin, it is, of course, probable that some of the resin may seep through them and bond with resin from other particles. As a matter of fact, the binder does not appear to have any pronounced insulating action and it may well happen that the theory first above given is correct.

In order that my disclosure shall be complete, the following specific directions for making 1000 resistors, each having a resistance of 700 ohms and each capable of dissipating one watt, are given:

For the above purpose, I take 5 lbs. of glass ground to pass a 150 mesh screen, 2¼ lbs. of air-floated asbestos, and mix them in a kneader with 1.62 lbs. of phenol-formaldehyde resin dissolved in 8 lbs. of acetone.

To coat the amount of filler material specified, in order to obtain the desired resistance characteristic, requires .126 lbs. of graphite. This weight of graphite is contained in .63 lbs. of commercial aquadag which is diluted by adding to it approximately 5½ pints of distilled water to form a colloidal suspension having the required density.

The following table gives relative proportions of filler, resin, and carbon for a number of finished resistors ¾" long and ¼" in diameter:

Asbestos	Resin	Graphite	Carbon black	Glass	Resistance
Percent	Percent	Percent	Percent	Percent	
72	25	3	----------	----------	700 ohms.
73	25	2	----------	----------	2000 ohms.
74	24.5	1.5	----------	----------	500000 ohms.
24	18	.7	2.3	55	1.2 megohm.
24	18	1.2	2.3	54	17000 ohms.
24	18	1.4	2.3	54	11000 ohms.

From the foregoing table, it will be apparent

that a resistor having any desired resistance characteristics may be made by suitably choosing the relative amounts of filler and conducting material. It will also be noted from the table that the variation in the resin content plays a very minor part in the resistance of the finished article, which is in accordance with the theory hereinbefore advanced.

After baking, the resistor rods must, of course, be provided with suitable terminals. For this purpose, I find it best to utilize the Schoop metal spraying process and I apply to each end of the resistor a ring of copper or tin extending inwardly from the end a distance of $\frac{3}{16}$''. Obviously, the resistance of the rod measured from end to end can be further controlled at this point in the process by adjusting the width of the sprayed terminals. As a general rule, however, this is not done in the factory, for the reason that it is much more convenient to so arrange the spraying machinery that all resistors are provided with terminals of the same width.

After the terminals have been sprayed onto the ends of the rods, the rods are immersed in a moisture-repellent impregnating material such as melted carnauba wax, aerclor, halowax, sincera wax, cerawax, paraffin, linseed oil, or the like, which has no solvent action on the polymerized resin at any operating temperature. The melted wax is preferably maintained at a temperature of 170° C., and the rods are kept therein for approximately forty five minutes. Carnauba wax is particularly advantageous to use as the impregnating material since, by reason of its expansion within the interstices of the resistor rod, at temperatures below its melting point, it compensates, to some extent, for changes in resistance occasioned by temperature rise. I have also found linseed oil to be quite satisfactory, since it oxidizes and forms a surface coating which is thoroughly waterproof. Linseed oil, however, necessitates an extra baking step to effect this oxidation.

A resistor manufactured according to my improved method offers many advantages not heretofore obtained. In the first place, the process utilizes carbon which can be purchased in its processed form and is immediately available. Secondly, the resistance values can be duplicated fairly accurately and, in addition, the electrical characteristics can be accurately determined and controlled, while the finished resistors exhibit extremely low load coefficients of resistivity. Naturally, I am aware that certain of the mentioned advantages have been approached in the past, but it is my belief that no resistor now on the market exhibits them to as great an extent as a resistor manufactured according to my improved process.

Although I have disclosed herein certain specific proportions of filler, resin, and conducting material, these are given merely by way of example and are not to be construed as in any way circumscribing the scope of my invention. Many other modifications will be apparent to those skilled in the art and my invention, therefore, is not to be limited except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. An as element of a resistor device, a particle of inert, substantially non-conductive filler material, a coating of insulating material thereon, and a film of conducting material upon the outer surface of the insulating material.

2. As an article of manufacture, a resistor composed of particles of inert filler, substantially all of said particles being respectively coated with an insulating material carrying an outer film of conducting material, the films of conducting material being in intimate contact with each other throughout the mass of said resistor.

3. The invention set forth in claim 2, wherein the insulating material is a polymerized phenol formaldehyde resin.

4. The invention set forth in claim 2 wherein the conducting material films are bonded together into a quasi-honeycomb structure.

5. The process of manufacturing a material from which resistors may be formed which comprises coating a plurality of particles of inert material with an insulating layer and thereafter depositing a conducting surface film upon substantially all of said particles.

6. The process of manufacturing a material from which resistors may be formed which comprises coating the surface of a plurality of particles of inert filler material with a polymerizable material, and thereafter causing a film of conducting material to be deposited upon the surface of the polymerizable coating.

7. The method of manufacturing a material from which resistors may be formed which comprises mixing a mass of inert material particles with a solution of a polymerizable material in a volatile solvent, causing the solvent to evaporate and then applying to the surface of substantially all of said particles an adherent coating of conducting material.

8. The invention set forth in claim 7 characterized in that the inert material is a mixture of asbestos particles and ground glass.

9. The method of manufacturing a material from which resistors may be formed which comprises moistening a mass of air-floated asbestos with a solution of a phenol formaldehyde resin in a volatile solvent, causing the solvent to evaporate, mixing the residuum with a colloidal suspension of carbon, causing the carbon to be precipitated from the suspension onto the surfaces of substantially all of the particles of asbestos, and thereafter removing the remaining solute.

10. The method of manufacturing fixed resistors which comprises intimately mixing a mass of comminuted inert filler material with a solution of phenol formaldehyde resin in a volatile solvent, causing the solvent to evaporate whereby the resin is deposited as a coating upon the particles of filler, mixing the coated particles with a colloidal suspension of carbon, causing the suspension to coagulate to thereby precipitate the carbon onto the surfaces of the particles, removing the surplus vehicle of the suspension, molding the residuum into appropriate shapes, and thereafter baking the molded articles at a temperature sufficiently high and for a sufficient length of time to cause the resin to polymerize.

11. The invention set forth in claim 10 characterized in that the inert filler material is asbestos and ground glass.

12. The method of manufacturing a material from which resistors may be formed which comprises moistening a mass of inert filler particles with a solution of phenol-formaldehyde resin and a reagent capable of causing the coagulation of a colloidal suspension of carbon in a volatile solvent, causing the solvent to evaporate, and introducing the resin-coated filler particles into a colloidal suspension of carbon.

13. The method of maufacturing a material from which resistors may be formed which comprises moistening a mass of inert filler particles with a solution of phenol-formaldehyde resin and furfural in a volatile solvent, causing the solvent to evaporate, and introducing the resin-coated filler particles into a colloidal suspension of carbon.

14. The method of manufacturing a material from which resistors may be formed which includes moistening a mass of inert filler particles with a solution of a phenol formaldehyde resin and an organic acid dissolved in acetone, causing the solvent to evaporate, and introducing the resin-coated filler particles into a colloidal suspension of carbon.

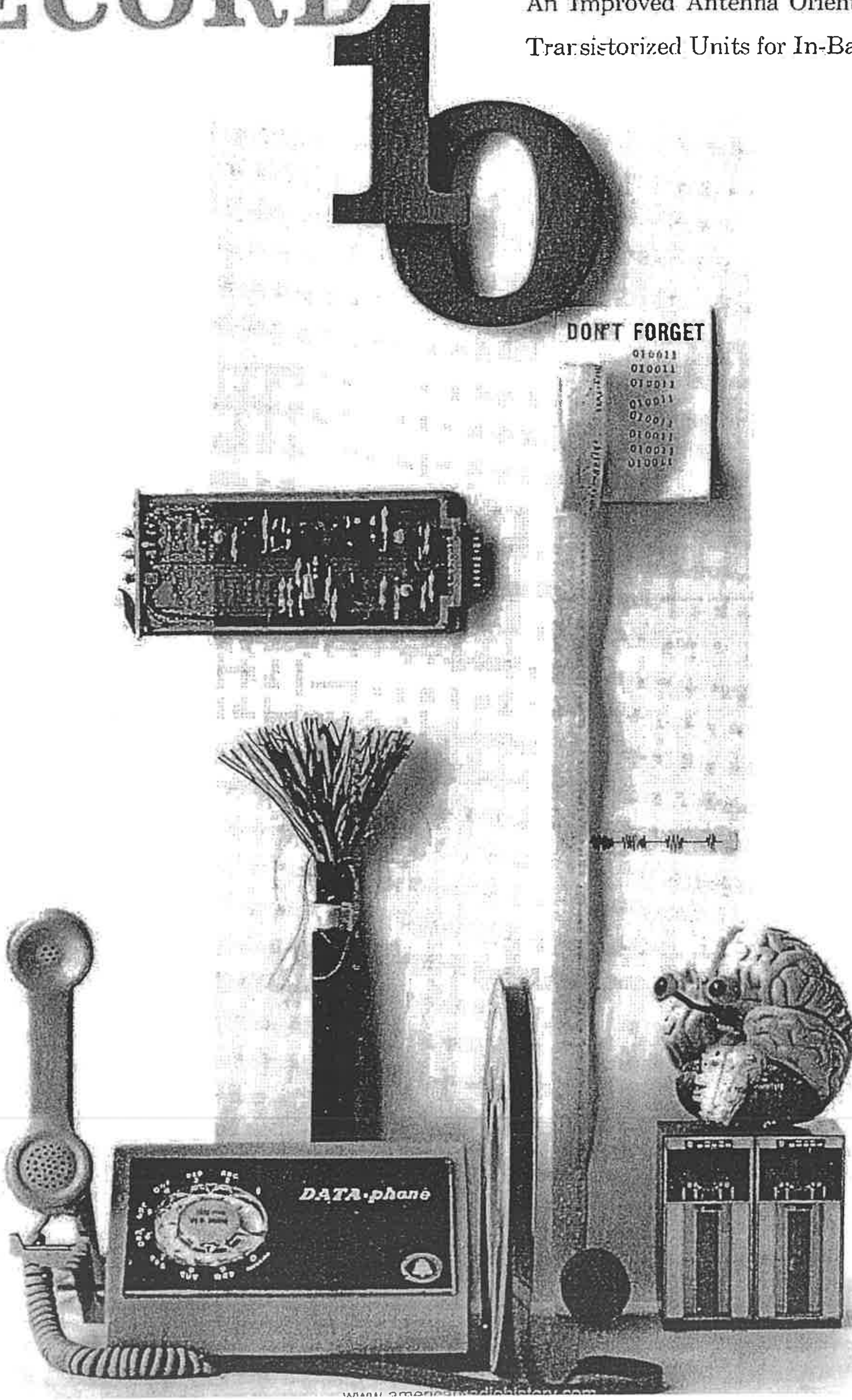
15. A resistor element in the form of a rod constituted by a plurality of particles of inert filler, substantially all of said particles having a first coating of an insulating material and an outer coating of graphite and carbon black, the said particles being in such intimate contact with each other that a substantially uninterrupted electrically conductive path is established between the ends of the rod.

16. The method of manufacturing a resistor which comprises coating each of a plurality of particles of inert filler with polymerizable resin, superimposing a film of conducting material upon the resin coating, compressing the filmed particles into a coherent mass, polymerizing the resin coating to lock the particles in place and thereafter impregnating the mass with a moisture repellent material incapable of dissolving the polymerized resin at temperatures encountered during ordinary use of the resistor.

SIDNEY BLOOMENTHAL.

ll Laboratories October 1960

RECORD



THE BELL LABORATORIES RECORD is published monthly by Bell Telephone Laboratories, Incorporated, 463 West Street, New York 14, N. Y., J. B. FISK, President; K. PRINCE, Secretary; and T. J. MONTIGEL, Treasurer. Subscription: $2.00 per year; Foreign, $2.60 per year. Checks should be made payable to Bell Laboratories Record and addressed to the Circulation Manager. Printed in U. S. A.

The Bell System uses some devices by the millions. Redesigning one of these devices to cut costs by even a small amount can result in important savings to the Bell System. A typical redesign of this kind, on a widely used power resistor, was recently completed at the Laboratories.

R. J. Wirtz

A New Design for Power Resistors

The complexity of a telephone system is due in part to the variety of equipment, devices, and materials it uses. Some of these items are relatively new to the arts of telephone switching and transmission. Germanium or silicon devices, for example, have only recently been incorporated into new designs to any extent. But many of the better known devices—resistors, capacitors, and inductors—have served the telephone system for a long time. Typical of these venerable units in the Bell System are the power resistors known by the code names "18 and 19 Flat-Type Resistors."

These resistors, associated with station apparatus and transmission and switching facilities, are categorized as "general use" items. As such, they have found numerous applications in the Bell System. The first designs were manufactured by the Western Electric Company as early as 1901. Because of their extensive use and unique appearance, flat-type resistors performed a very special service during World War II. At that time, they served to identify equipment manufactured by the Western Electric Company. This expedited a sizable sorting process on the invasion beaches of Europe. The 18- and 19-type resistors have an excellent record of past performance in the telephone plant and have earned the reputation of "old standby."

Physical Dimensions

These wire-wound resistors can dissipate approximately 5 watts of power under normal conditions, and as much as 12 watts, for limited periods, under trouble conditions. They are flat in appearance, measuring approximately ⅜-inch thick by 1¾-inches wide by 4¾-inches long. They can be mounted in banks on 7/16-inch-minimum centers. The 18-type resistors have a single winding and two rigid terminals, while the 19-type resistors have two windings and three rigid terminals. In 1959, demand in the Bell System for these Western Electric resistors was something over six million per year.

Obviously, such a high demand makes it worthwhile to attempt to cut down the cost of these resistors, if it can be done without sacrificing

R. F. Leach, left, and author discuss attributes of the new 19-type resistor. On display board at rear are variety of Bell System resistors.

quality. And so it was that these resistors were completely redesigned in a lengthy program combining efforts of both Bell Laboratories and Western Electric. This program was completed just a few years ago when initial production of the newly designed resistors began at the Kearny, New Jersey, plant of the Western Electric Company.

The primary objectives of this redesign were to eliminate various items of insulators and mounting hardware, and adapt the resistors for modern methods of production. Such factors contribute directly to a substantial reduction in cost, reflected partly in the unit cost of the resistor and partly in the cost of mounting or assembling it into equipment. Moreover, there is a long-term savings attributable to an improved product.

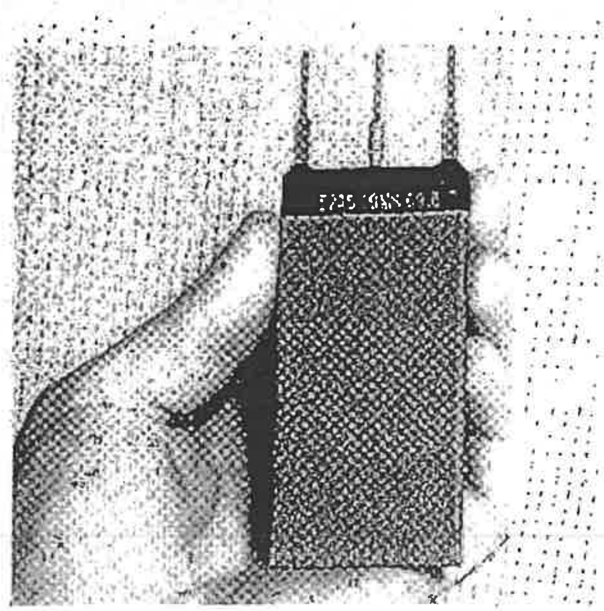
The improvements in design included three major items. First, designers superimposed windings on an insulated metal core and terminated the resistance wire by spot welding it to the core and terminal. Old-style resistors had windings side by side on a phenolized asbestos core with soldered splices and terminations.

Second, they provided an insulated mounting surface for the resistors by assembling a phenolic terminal head molded integrally with the metal core. The old designs required mounting-plate bushings, insulator washers on both sides of the mounting plate, and metal mounting washers.

Finally, the designers secured the new resistors to the mounting plate by a single, centrally located mounting stud for the 18-type resistors. This mounting stud doubles as the third terminal post for the 19-type resistors.

In addition, new design 18- and 19-type resistors have terminals to accommodate either soldered or solderless wrapped wire connections (RECORD, *February*, 1954). The entire body of the resistor is covered with an envelope of phenolized asbestos, completely insulating the structure on the apparatus side of the mounting plate. Old-style resistors had metallic terminal side posts exposed over the entire length of the body. Also, code and resistance-value markings on the new style are stamped on the molded head where they are legible when the resistors are mounted in place. This is in contrast to the old style markings that were printed on a label affixed to the resistor body, where they were unreadable when the resistors were mounted. As with the old style, the resistance-value markings for the 19-type resistor are oriented to identify unequal windings.

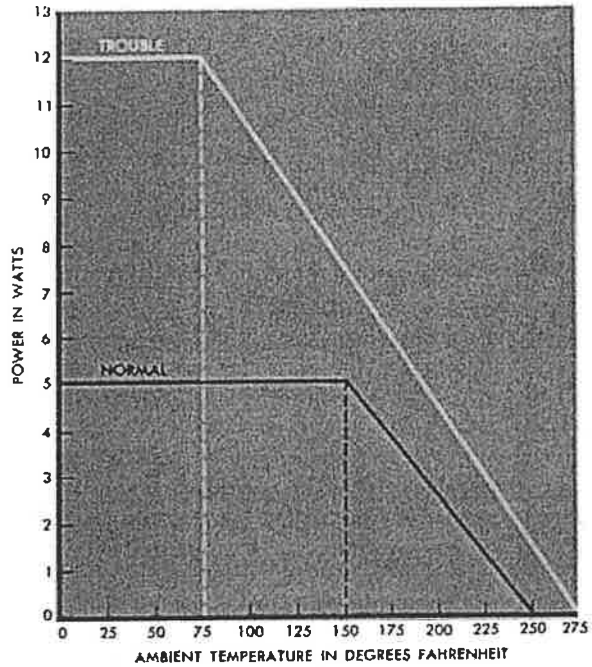
The new designs feature detail parts that lend themselves to be fabricated, machined, and assembled by modern production methods. This is especially true of parts such as a metal card that combines the core and the terminals. It is also true of the mounting stud and center terminal, and the molded-phenolic head unit and envelopes of asbestos that encase the resistors.



The redesigned 19-type resistor. Center mounting stud is designed to be a third terminal post.

For a given power-dissipation, the operating temperature of the new resistor is lower than that of the old. This is because the metal core acts as a "heat sink," distributing the heat evenly over the entire body of the resistor. The result is lower "hot-spot" temperatures. Based on experimental data, power rating characteristics were derived for the new resistors. These are illustrated in the graph, right. Here, the "normal" power rating is 5.1 watts. For each degree that the ambient temperature exceeds 150 degrees F, the rating decreases about one per cent of the normal rating, or about 1/20th of a watt. "Trouble" power rating is shown as 12 watts with a decrease of about one-half of one per cent, or 1/16th of a watt, for each degree the ambient temperature exceeds 75 degrees F. A trouble condition is a temporary overload condition due to a circuit malfunction. Resistors can be operated at "trouble" power ratings safely for twenty-four hours.

At the time redesigns were contemplated, there was a large quantity of old-style resistors already in the field. It was essential, therefore for the new styles to be designed electrically and mechanically interchangeable with the old. For this reason, the new designs were tailored to have their over-all function and appearance governed by the electrical characteristics and physical dimensions of the old-style resistors.



Power rating characteristics of the new resistors show "normal" at 5.1 watts, "trouble" at 12 watts.

Electrical Protection

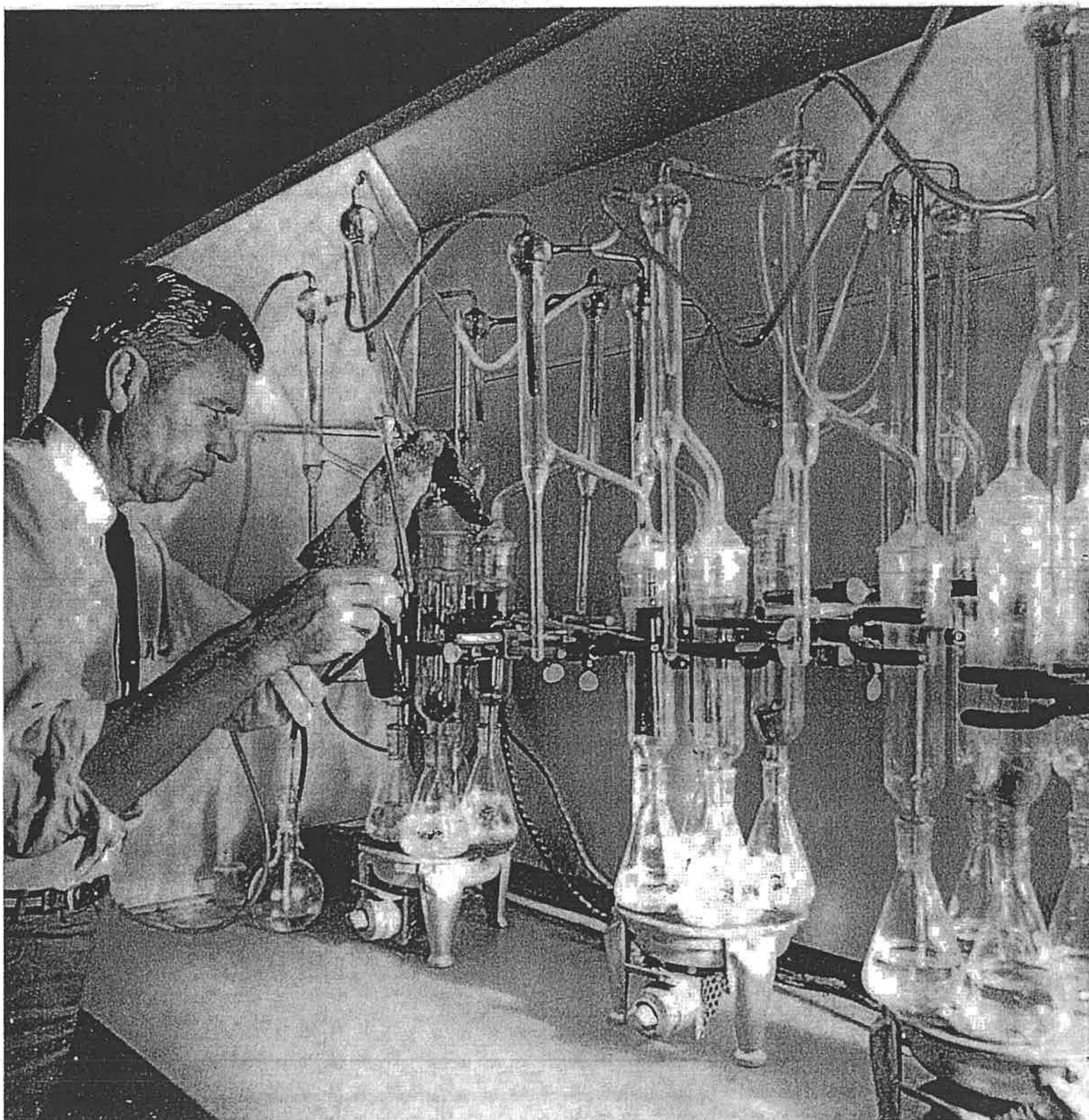
Because of their completely insulated structure, the redesigned resistors have no "live" parts behind the panel on which they are mounted. Therefore, they do not require the insulators and shields normally used on the old-style resistors for electrical protection against the exposed metal side posts and the center post.

The new designs have their terminal insulation integral with the molded head. This eliminates the need for mounting-plate bushings, used for insulating old-style resistor terminals. In the event of a field replacement (where a new-style resistor replaces an old) the bushings must be removed before the new resistor is mounted. With the introduction of the redesigned resistors, the now obsolete insulator bushings are no longer being supplied in newly manufactured mounting plates. Thus, to maintain interchangeability, designers had to devise a way of mounting old-style resistors in the unbushed holes of these new mounting plates. They therefore supplied a new molded-strip insulator to take the place of the bushings. For additional economy, this insulator also replaces two insulating washers formerly required on the apparatus side of the mounting plate.

Since the new designs are electrically interchangeable with the old, the Bell System has retained the old code designations. This has avoided the expense of a substantial amount of drafting, clerical, and engineering effort that otherwise would have been involved in changing an estimated 100,000 drawings—Bell Laboratories equipment and circuit drawings as well as Western Electric Company equipment drawings and wiring diagrams.

During the period from initial to full-scale production of the new design, the Western Electric Company produced both new- and old-style resistors. However, production of the old style was reduced progressively until today, all requirements for 18- and 19-type resistors are being filled with the new design.

In its redesign program, the Bell System reviews long-existing items and judges them in the light of their present use. It also takes a close look at their quality and reliability requirements, and at their methods of manufacture. Effort devoted to this type of review results in the improvement of components. And for those manufactured in a large volume, such as the 18- and 19-type resistors, it can save much money for the Bell System.



John Leutritz places a wire-mesh basket containing wood wafers into a flask of boiling toluene. As the vapors pass through the wafers, the preservative is removed, and signs of decay can be seen.

EXHIBIT H

SAFE PRACTICE DATA SHEET A-20

ASBESTOS

Asbestos is used in many varied forms such as board, cloth, fiber, rope packing, sleeving, tape, twine, yarn, sheet, and in other numerous combinations. The manner of storage depends upon the form of asbestos. Where the asbestos may possibly be in a loose form during storage, a dusty condition could be produced and proper ventilation should be provided.

PROPERTIES

FIRE - Non-flammable.

EXPLOSION - Non-explosive.

BREATHING - Dust from asbestos materials may produce a chronic lung disease if it is breathed in sufficient concentrations over a period of years. In some persons, the disease may develop much more rapidly than in others. The concentration and particle size of the dust will also influence the number of years of exposure required to produce the disease. In any case, exposure even to high concentrations of asbestos dust for a period of a few days or even a few months will not produce the disease. Particles larger than about 10 microns (0.000039 in.) cannot get into the small lung air sacs to cause damage. Such small particles are far below the size which is visible to the naked eye. Most dusts, however, have particles of a large range of sizes which vary from visible to invisible. It is only the fine invisible dust particles that are effective in producing asbestosis.

Where people may breathe the dust, the Maximum Allowable Concentration is 5 million particles per cubic foot of air, unless the exposure is for less than one hour per day, in which case a slightly higher concentration may be permitted but must not exceed 10 million particles per cubic foot. These Maximum Allowable Concentrations apply to repeated or recurring daily exposures. Where asbestos may be mixed with other less harmful dusts, the concentration of asbestos dust will be the controlling factor. The asbestos dust concentration can be determined by collecting and analyzing air samples.

SKIN IRRITATION - Asbestos is usually not a skin irritant.

PERSONAL PROTECTIVE EQUIPMENT

WHEN IT IS NECESSARY TO WORK IN AN AREA CONTAINING HIGH DUST CONCENTRATIONS, AN AIR-LINE RESPIRATOR OR HOSE MASK WITH OR WITHOUT A BLOWER MAY BE USED. The air-line respirator should have 8 to 15 lbs/sq.in. pressure. Care should be taken so that contaminated air does not enter the hose for the hose mask.

For medium dust concentrations, the standard all dust respirator 8883-5, equipped with filter 8883-6, may be used. Filters should be replaced according to a predetermined schedule or at any time breathing becomes difficult.

All respirators and replacement parts should have the Bureau of Mines approval which is indicated by a label on larger parts or BM#______(approval number) on smaller parts.

PRECAUTIONS

A PERSON SHOULD NOT ENTER AN AREA CONTAINING AN EXTREMELY HIGH CONCENTRATION OF ASBESTOS DUST FOR A PROLONGED PERIOD OF TIME WITHOUT ADEQUATE PROTECTION. THE MAXIMUM ALLOWABLE CONCENTRATION

WHEN IN DOUBT
CONSULT MEDICAL OR SAFETY DEPARTMENT

Printed in U.S.A. ... HYGIENE LAB EAST PITTSBURGH, PA.

ASBESTOS (Continued)

OF 5 MILLION PARTICLES OF DUST PER CUBIC FOOT OF AIR SHOULD NOT BE EXCEEDED FOR REPEATED OR CONTINUOUS EXPOSURES. THIS MAY BE ACCOMPLISHED BY COMPLETELY ENCLOSING THE SYSTEM OR BY PROVIDING ADEQUATE VENTILATION. PROPER PREPLACEMENT AND PERIODIC PHYSICAL EXAMINATIONS SHOULD BE MADE BY THE MEDICAL DEPARTMENT ON PERSONS WHO WORK WHERE THERE IS REPEATED OR RECURRING EXPOSURE TO ASBESTOS DUST.

WHEN IN DOUBT
CONSULT MEDICAL OR SAFETY DEPARTMENT

East Pittsburgh, 2-G-46
Industrial Hygiene Laboratory

June 11, 1954

SOUTH PHILADELPHIA WORKS
Industrial Relations
Mr. W. E. McKeldin
Safety Supervisor

With respect to the room in which asbestos cloth is being cut and sewed, the air samples did not indicate exposure to concentrations of asbestos dust above 5 million particles per cubic foot, which is presently regarded as the maximum allowable concentration. However, I have a feeling that these concentrations may vary from time to time in the room. It would be very desirable to ventilate the room more effectively so that the amount of asbestos dust in the breathing atmosphere would be further reduced. When sheet material is being thrown from one bench to another, the concentrations of asbestos fibers in the breathing atmosphere of the sewer in particular would appear to be potentially hazardous. As you know, in the State of Pennsylvania, when a person's chest contains some silicosis and it becomes superimposed with tuberculosis, that this disease becomes compensable. I believe that the same is true in the case of asbestosis. Frequently, the early stages of asbestosis or silicosis are difficult to detect by X-rays and it is also believed that persons suffering from beginning stages of asbestosis or silicosis are more likely to develop tuberculosis. We have such a case in Compensation Court from one of our plants at the present time and they are difficult cases to handle.

As you know, the present fan in the side wall of this room is quite noisy and the men do not operate it more than necessary on account of the noise situation. Therefore, the ventilation of this room should be reconsidered. In the revision of the ventilation of this room, it might be most desirable to have the fan placed on the side of the room with the large number of windows since a good portion of the dust already is moving in this direction. It would be desirable to use a different type of fan in the improvement of this room. By placing the fan on the side wall presently containing most of the windows, the dust fibers collecting along this side of the wall would be ventilated to the outside of the building rather than dragged past the breathing level of the men doing the sewing.

I will greatly appreciate knowing what your final decision on this problem will be.

E. Wilber Speicher, Administrator
Industrial Hygiene

P.S. These dust samples were found to contain extremely fine particles which would indicate their being more hazardous.

EWS

P.001 TX/RX NO.5615 06/06/00 15:00 *Westinghouse*

DN 65711AA-AJ — PD SPEC (PDS) —
RL Rev W
DA Mar 5, 1976

TI CABLE, ASBESTOS INSULATED

CA CAUTION: CUTTING OR MACHINING WILL PRODUCE ASBESTOS DUST. DUST SHALL NOT BE BREATHED. ADEQUATE LOCAL EXHAUST VENTILATION SHALL BE PROVIDED. SEE SPDS.A-20.

SU SUPPLIERS:

(65711AA)		A-B-D-E-F-G
(65711AB)		A-B-C-D-E-F-G
(65711AC)		C-D
(65711DJ)	(All Plants except Elevator)	A-B-D
	(Elevator)	A-B-D-H

(A) Cerro Wire and Cable Co (Cerro) 650 Nicoll St, New Haven, CT 06504
(B) Coleman Cable Co, 1900 N Fifth Ave, River Grove, IL 60161
(D) Continental Wire and Cable Corp (Anaconda) Gulbon Rd, York, P 17404
(E) Okonite Co, PO Box 340, Ramsey, NJ 07446
(F) Phelps Dodge Cable and Wire Co, Foot of Point St, Yonker, NY 10702
(G) Radix Wire Co, 26262 Lakeland Blvd, Cleveland, OH 44132
(H) United States Steel Corp (Wire and Cable Div) Bellard St, Worchester, MA 01607

OR ORDER FROM SUPPLIER AS: Cable (or Wire), stating P D Spec Number and Rev Letter.

CH CHARACTERISTICS:

Grade	Previous Grade	Users	Insulation	Treated Braid
65711AA	7419-2	BQ BS BP JC MAR SDD	VC & Asb	Asbg
65711AB	7419-3	BQ BS BP JC LAE PT PTB SH	Asb	Asbg
65711AC	7419-4	NE	Asb	Asb
65711AD	7419-5		Obsolete.	
65711AE	7419-8		Obsolete.	
65711AF	7419-12		Obsolete.	
65711AG	7419-15		Obsolete.	
65711AH	7419-16		Obsolete.	
65711AJ	7419-1	BE BG BS EP JC NE SDD	VC & Asb	Cottong

Grade	Braide Color	Type	Voltage*
65711AA	Black	AVA	600
65711AB	Black	AIA	600
65711AC	Black	AIA	600
65711AD			
65711AE			
65711AF			
65711AG			
65711AH			
65711AJ	Gray	AVB	600

Tinned copper wire, except 65711AB has untinned conductor
* Unless otherwise specified.
# Contains fungicide.
Circuit voltage, phase to phase.

AP APPLICATION:
(65711AA,AJ) Switchboard and control wiring.
(65711AB,AC) Apparatus leads; general use.

CP CORPORATE PART NUMBER: PDS No. + Size Code
Example: 65711AA99L (CABLE - If reference name is desired)

PDS 42331AA thru AC Rev AA Jul

ASBESTOS PAPER
CAUTION: DUST RESULTING FROM HANDLING OR MACHINING SHALL NOT BE BREATHED. USE ONLY WI
LOCAL EXHAUST VENTILATION. SEE SPDS A-20.
SUPPLIERS -

(42331AA)	(Except .007" & .010" thk)		A-B
	(.007" thk only)		B
	(.010" thk only)	(Except HA)	B
		(For HA)	A-B

(A) Johns-Manville, Greenwood Plaza, Denver, CO 80217
(B) Nicolet, Inc, Wissahickon Ave, Ambler, PA 19002

ORDER FROM SUPPLIER AS - (42331AA) Paper, P D Spec 42331AA Rev AA.

CHARACTERISTICS - 42331AA (Previous 2118-1)(Users:AMD,BE,BG,BM,EMM,DA,EP,HA,M&R,PT,SH,S
Commerical grade asbestos paper of uniform quality.
42331AB (Previous 2118-2) Obsolete.
42331AC (Previous 2118-3) Obsolete.

For properties & dimensions see FDS.

APPLICATION - General use.

SPECIFY BY - CODED IDENT (PDS No. + Size Code)
Example: 42331AA3GD (ASB PAPER - If reference name is desired)

WESTINGHOUSE PROPRIETARY

M 46316AJ thru AM Rev B Jul 20, 1976

MOLDED PARTS, CALCIUM SILICATE-ASBESTOS
CAUTION: MACHINING PRODUCES ASBESTOS DUST. DUST SHALL NOT BE BREATHED. ADEQUATE LOCAL EXHAUST VENTILATION SHALL BE PROVIDED. SEE SPDS A-20.
SUPPLIERS - American Insulator Corp, 1930 Main St, New Freedom, PA 17349

ORDER FROM SUPPLIER AS -
(46316AJ,AL,AM) AICO 5, stating drawing and item number.
(46316AK) AICO 5 plus 1.5% Carbon Black, stating drawing and item number.

CHARACTERISTICS - 46316AJ (Previous 161-1)(User:BG) White, inorganic, cold molded composition consisting of calcium silicate and asbestos, having properties as follows:

Tensile Strength, Psi	2200
Compressive Str, Psi	10910
Flexural Strength, Psi	3783
Impact Str, Ft-Lb/In-Notch	.46
Dielectric Strength, VPM	43
Arc Resistance, Sec	556
Heat Resistance, F	1000
Specific Gravity	1.84
Moisture Abs, 24 hr, %	4-13

CANCELLED
6-20-84

46316AK (Previous 161-2)(User:BG) Same as 46316AJ except black. Contains 1.5% carbon black.
46316AL,AM (Previous 161-3,-4)(User:BG) Same as 46316AJ except for specific applications.

APPLICATION - (46316AJ) Intricate inorganic cold molded parts.
(46316AK,AL) Cold molded parts such as arc boxes.
(46316AM) Cold molded insulating spacers for rotary switches.

SPECIFY BY - CODED IDENT (M No.)
Example: 46316AJ (SILICATE ASB - If reference name is desired)

Printed in U.S.A. W Corp Std R&D (Fed. CODE IDENT NO. 79500)

30071419

M 41521CC Rev B OBS./CANCELLED 5/5/78 Jul 5, 1976

WESTINGHOUSE PROPRIETARY

CLOTH, ASBESTOS, SILICONE VARNISH TREATED

CONVERTED TO

CAUTION: DUST RESULTING FROM HANDLING OR MACHINING SHALL NOT BE BREATHED. USE ONLY WITH ADEQUATE LOCAL EXHAUST VENTILATION. SEE SPDS A-20.

SUPERSEDED BY..................

SUPPLIERS - Westinghouse Electric Corp, IMD, Bedford, PA 15522

ORDER FROM SUPPLIER AS - Treated Cloth 41521CC*

*Stating "Permanently mark all containers with Westinghouse M number."

CHARACTERISTICS - (Previous 1296-1)(User:M&R) Asbestos cloth 41511BB treated with silicone varnish 32102FH.

APPLICATION - Armature insulation.

SPECIFY BY - CODED IDENT (M No. + Size Code)
Example: 41521CC1JX (TR ASB CLOTH - If reference name is desired)

Printed in U.S.A. W Corp Std R&D (Fed. CODE IDENT NO. 79500)

30020362

DN 41511AA - PD SPEC (PDS) -
RL Rev A
DA Jul 5, 1976

-

TI ASBESTOS TAPE, WOVEN

-

CA CAUTION: DUST RESULTING FROM HANDLING OR MACHINING SHALL NOT BE BREATHED. USE ONLY WITH ADEQUATE LOCAL EXHAUST VENTILATION. SEE SPDS A-20.

-

SU SUPPLIERS:
(A) Amatex Corp, 1030 Stanbridge St, Norristown, PA 19404
(B) Atlas Textile Co, 538 Walnut St, North Wales, PA 19454
(C) H K Porter, Inc, 1000 Seaboard St, Charlotte, NC 28206
(D) Raybestos-Manhattan, Inc, 100 Oakview Dr, Trumbull, CT 06611
(E) Uniroyal, 1230 Ave of Americas, NY, NY 10020

-

(.010" thk)	A-B-E
(.015", .025" thk)	A-B-C-D-E

-

OR ORDER FROM SUPPLIER AS: Tape, P D Spec 41511AA Rev A.

-

CH CHARACTERISTICS: (Previous 1598) (Users: BM EP JC MAR PT SH) Closely woven, unsized asbestos tape, .010", .015" and .025" thk. Tape .015" thk and over is constructed of asbestos yarns, both warp and fill, which may contain 20% (max) cotton. Tape .010" thk contains in addition to asbestos warp yarns two cotton threads at each edge and filler is of fine cotton yarn. Cotton content of asbestos warp threads is approx 17% and total percentage of cotton is approx 27%.

-

For additional properties and construction details see PDS.

-

TL TOLERANCES: See PDS

-

EQ EQUIVALENTS(ref only): MIL-I-3053, tape. grade U.G., type 2PU

-

TRADENAMES: MIL I 3053 GR U G TYPE 2PU

-

AP APPLICATION: Taping TI 130 armature coils.

-

CP CORPORATE PART NUMBER: PDS No. + Size Code
Example: 41511AA1BM (ASB TAPE - If reference name is desired)

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DN 42231AA-AB - PD SPEC (PDS) -
RL Rev D
DA Jan 20, 1977
-
TI ABESTOS PAPER
-
CA CAUTION: DUST RESULTING FROM HANDLING OR MACHINING SHALL NOT BE BREATHED. USE ONLY WITH ADEQUATE LOCAL EXHAUST VENTILATION. SEE SPDS A-20.
-
SU SUPPLIERS:
(42231AA) Johns-Manville, Greenwood Plaza, Denver, CO 80217
-
OR ORDER FROM SUPPLIER AS: (42231AA) Paper, P D Spec 42231AA Rev D.
-
CH CHARACTERISTICS: 42231AA (Previous 4262-1) (User: BM BMM CL EP M&R TM) High grade asbestos paper composed of nonferrous type asbestos fiber specially manufactured to be free from conducting particles. It is much freer from conducting particles than commercial asbestos paper 42331AA and is considerably more expensive.
-

Thk, Inch.	Tens Str, Min (Lb/In Width)		Tear Str, Min (Gm/In. Width)		Apparent Density Grams/cc		Basis Weight, Lb/100 Sq Ft	
Nom	MD	CMD	MD	CMD	Min	Max	Min	Max
0.005	12	7	20	28	.65	.91	1.7	2.3
.0065	15	9	28	39	.76	.89	2.4	3.1
.007	17	10	29	40	.69	.95	2.9	3.5
.010	20	12	40	47	.67	.92	3.6	4.8
.015	23	13	62	77	.69	.94	5.5	7.5

-
42231AB (Previous 4262-2) Obsolete.
-
TL TOLERANCES: See PDS
-
EQ EQUIVALENTS(ref only): MIL-I-3053, type 2PU
TRADENAMES: MIL I 3053 TYPE 2PU QUINORGO 4000
-
AP APPLICATION: Treated with shellac for field coil insulation.
-
CP CORPORATE PART NUMBER: PDS No. + Size Code
Example: 42231AA18Q (ASB PAPER - If reference name is desired)

EXHIBIT I

APA36/9030/pn

Equipment	Serial No	Field Change No.
TED-5	939, 919, 925 909, 888, 878	3 3
TED-7	583	2
R-390A/URR	690, 395, 652	1
AN/GRC-27A Remote	1499, 5735	3, 4, 5, 6, 7, 9
AN/URC-32	218	5
RBO	3199, 4930, 2637	10
AN/SPA-4A	954, 1144	13, 14
AN/SPA-8A	1332, 1323	1
O-329/SP	328	2
AN/SPS-10B	146	1, 2, 7
AN/UQN-1C	514	1, 2, 3
AN/UPM-70	421	1
AN/USM-32	429, 1719, 2125	2
TV-3C/U	1802, 1939	2
TV-10A/U	655, 825	

(43er) The following ShipAlts are outstanding:

APA-800	Replace VJ's with AN/SPA-4A radar repeaters.
APA-961	Install additional remotes in Radio 1
APA-923	Relocate 5 MF/HF Receivers from Radio 1 to SAAC
APA428	Extend RBO System
APA-989	Facsimile Equipment
APA-981	Improve Antenna system
APA-986	Teletype Tape Facilities
APA-982	LF/MF Radio Equipment
APA-983	SSB Radio Equipment
APA-991	Automatic off-line Crypto (AN/SGA-3)
APA-980	On-line Security Equipment
APA992	Install improved ECM Equipment AN/WLR-1)
APA-973	AN/UNQ-7 Recorder
APA-950	Loran "C" Converter
APA-984	Improved Air Search Radar (AN/SPSA40)

NAVSHIPS 4661 (REV. 1-63)

SHIP ALTERATION MATERIAL SUMMARY

TO	SHIP	OVERHAUL PERIOD
Commander, Philadelphia Naval Shipyard	USS CAMBRIA (APA-36)	4-1-65 RESTRICTED AVAILABILITY

APPR.	SHIPALT	BRIEF OF SHIPALT AND EQUIP. DESCR.	QTY.	MILSTRIP/REMARKS
		AN/WLR-3 ECM Equipment	1	0868150329014 to NSY NORVA directs local release.
		AS-899A/SLR Direction Finding Antenna	1	0868150329036 to NSY NORVA directs local release.
		C-1609/SLR Control Unit	1	0868150329040 to NSY NORVA directs local release.
		AM-1017 ECM Amplifier	1	0868150329039 to NSY NORVA directs local release.
		AS-571/SLR Antenna	1	0868150329037 to NSY NORVA directs local release.
		AS-616A/SLR Direction Finding Antenna	1	08681-50329038 to NSY NORVA directs local release.
	APA-1003	AN/SPA-4D Radar Display	1	0868142459023 to NSC NORVA directs shipment to NSY NORVA.
	APA-1004	UHF RADIO EQUIPMENT		
		AN/SRC-20 Transceiver	3	(3) AN/GRC-27A On board, retain.
		TED Transmitter	11	On board, retain.
		AM-1365/URT RF Amplifier	6	0868151049045 to NSC NORVA directs shipment to NSY PHILA.

(2) to BUSHIPS Ltr., Ser. 527-418

DATE: 1 July 1964

ITEM NAME: RADAR SET

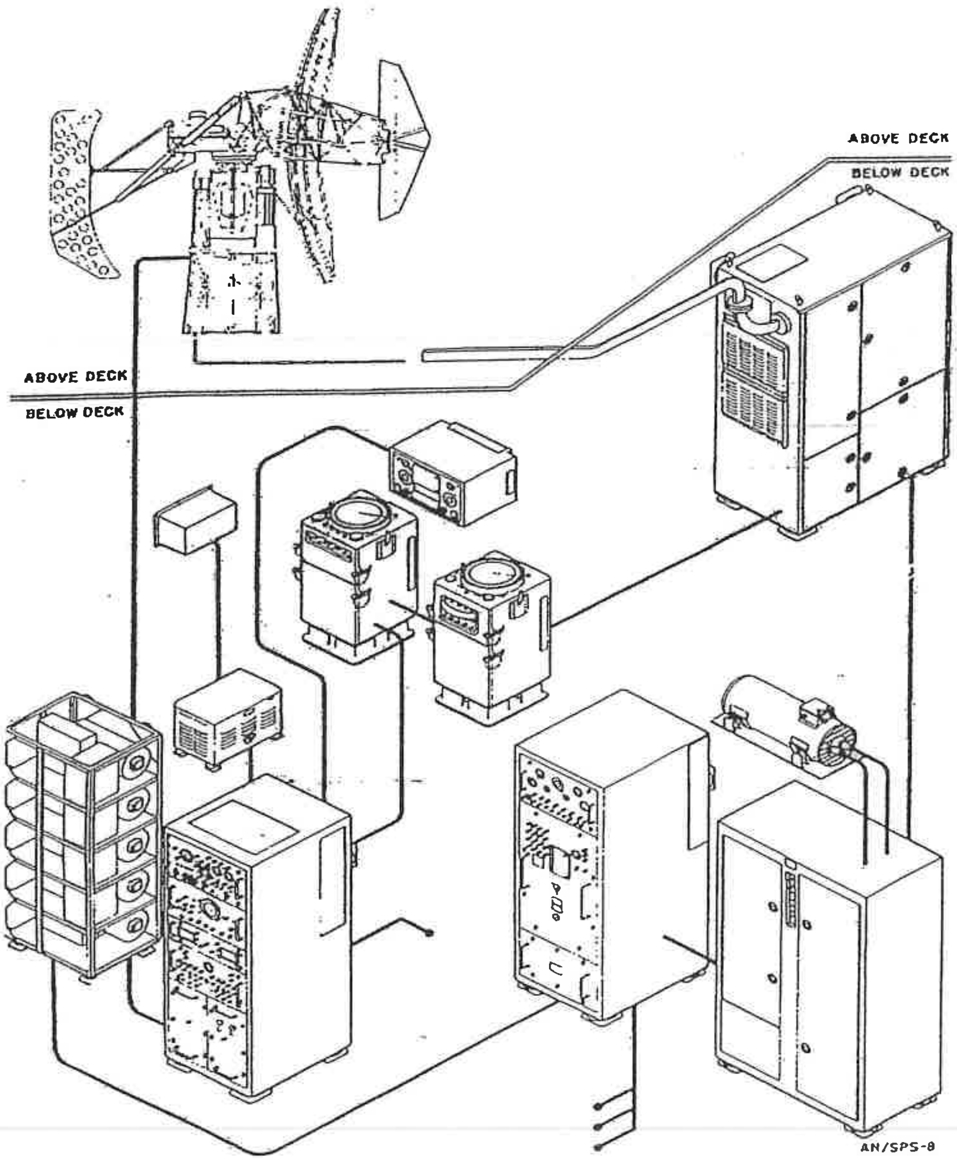
COGNIZANT SERVICE: USN

TYPE: AN/SPS-8*, -8A**, -8B

FEDERAL STOCK NUMBER: F5840- 644-4906*
F5840-665-1965**

	USA	USN	USAF	USMC
STATUS OR TYPE CLASSIFICATION		See Note 1		

Mfg(s) Name or Code Number: General Electric Company



AN/SPS-8, -8A, -8B

FUNCTIONAL DESCRIPTION

Radar Sets AN/SPS-8, -8A, and -8B are shipboard integrated search and height-finding radar systems used for the detection and surveillance of aircraft. It presents target height, slant range, bearing, and beacon information on Radar Repeater Equipments VK and VL.

The antenna is precisely stabilized by use of a stable element and the roll and pitch servo loops.

RELATION TO SIMILAR EQUIPMENT

None.

TECHNICAL DESCRIPTION

Frequency: 3430 to 3570 mc
Peak Power Output:
- AN/SPS-8 - 650 kw
- AN/SPS-8A, -8B - 1 megw

Pulse Repetition Rate:
- AN/SPS-8 - 500 and 1,000 pps
- AN/SPS-8A, -8B - 450 and 700 pps

Pulse Width:
- AN/SPS-8 - 1 and 2 -μsec
- AN/SPS-8A, -8B - 2 μsec

IF. Frequency: Radar 30 mc; beacon, 60 mc
Range, Max:
- AN/SPS-8 - 60 naut mi on two F2H fighter planes at 1,000 pps and 5 rpm
- AN/SPS-8A, -8B - 72 naut mi on two F2H fighter planes at 700 pps and 5 rpm

Antenna Feed:
- AN/SPS-8, -8A - Robinson horn scanner
- AN/SPS-8B - Organ pipe scanner

Horizontal Beam Width:
- AN/SPS-8, -8A - 3.5 deg
- AN/SPS-8B - 1.5 deg

Vertical Beam Width:
- AN/SPS-8, -8A - 1.1 deg
- AN/SPS-8B - 1.2 deg

Antenna Gain:
- AN/SPS-8, -8A - 37.5 db
- AN/SPS-8B - 41 db

Antenna Speed 1, 2, 3, 5,and 0 rpm, or manual
Azimuth Coverage: 30 to 200 deg
Elevation Coverage:
- AN/SPS-8, -8A - Any 11 deg sector between 0 and 36 deg
- AN/SPS-8B - Any 12 deg sector between 0 and 36 deg

Scan Rate:
- AN/SPS-8, -8A - 1,200, 600, and 300 rpm or manual
- AN/SPS-8B - 970, 720, and 360 rpm or manual

Reflector Elevation:
- AN/SPS-8, -8B - 4 to 29 deg
- AN/SPS-8B - 6 to 30 deg

INSTALLATION CONSIDERATIONS

Siting: To ease servicing and maintenance, place units as close together as possible. Receiver transmitter unit must be no more than 125 feet from antenna to avoid excessive moding and pulling of magnetron. 300 ft is the maximum recommended distance apart for other units. Place modulator close to transmitter to avoid loss through pulse cables. Place Radar Set Control C-1176/SPS-8A or C-677/ SPS-8 above the master VK and VL indicators.

Mounting: Bolt base shock mounts to deck and rear shock mounts to bulkhead. Bond each equipment cabinet to deck or bulkhead to protect personnel and prevent stray electric fields.

Cabling Requirements: Special procedure for assembling the high voltage pulse cables is given in Section 3 of NAVSHIPS 91988(A) or 91522(A).

Related Equipment: Navy Model VK Plan Position Indicator; Navy Model VL Range-Height Indicator.

AN/SPS-8, -8A, -8B

PRINCIPAL COMPONENTS AND PHYSICAL DATA

COMPONENT	QTY	HEIGHT (Inches)	WIDTH (Inches)	DEPTH (Inches)	UNIT WT. (Pounds)
AN/SPS-8					
DG Synchro Amplifier Mk 3 Mod 1A	1	12	14	20-1/4	104
Synchro Signal Amplifier Mk 7 Mod 2C	1	14-1/4	15-3/4	22-3/4	467
Antenna AS-484/SPS-8					3985
Radar Receiver-Transmitter Group OA- 160/SPS-8	1	31-7/32	45-1/2	70-3/16	1272
Capacitor Assembly CB-4/SPS-8	1	10	11	16	97
Radar Modulator MD-122/SPS-8	1	24	46	70	2243
AN/SPS-8A, -8B					
DG Synchro Amplifier Mk 3 Mod 1A or Mk 7 Mod 2C	1	12	14	20- ¼	104
Antenna AS-484A/SPS-8					5400
Antenna AS-828/SPS					4431
Radar Receiver-Transmitter Group OA-461/SPS-8A	1	31-7/32	45-1/2	70-3/16	1192
Capacitor Assembly CB-4/SPS-8	1	10	11	16	97
Radar Modulator MD-217/SPS-8A	1	24	46	70	2243

REFERENCE DATA AND LITERATURE

Technical Manual:
NAVSHIPS 91522(A)
NAVSHIPS 91988(A)

Note 1. Navy Status or Type Classification.
AN/SPS-B - Ltd Std
AN/SPS-8A - Sub Std
AN/SPS-8B - Std

DATE: 1 July 1964

ITEM NAME: RADAR SET

COGNIZANT SERVICE: USN

TYPE: AN/SPS-8D

FEDERAL STOCK NUMBER:

	USA	USN	USAF	USMC
STATUS OR TYPE CLASSIFICATION				
Mfg(s) Name or Code Number: General Electric Company, Syracuse, New York				

Illustration not available.

FUNCTIONAL DESCRIPTION

The AN/SPS-BD Radar Set is a shipborne three-coordinate radar used for search, detection, height finding and control of intercepts. Has continuous scanning in elevation and azimuth, presenting any 120 degrees elevation sector between o degrees and 36 degrees elevation for the full 360 degrees in azimuth at 2, 3, 5 or 10 rpm or manual search lighting or sector scanning, with 41 db high-gain fully stabilized antenna. It consists of Radar Set AN/SPS-BA and AS-828A/SPS Antenna.

EXHIBIT J

SHIP TEST MEMORANDUM

ELECTRONIC INTERFERENCE TEST

RECORDED DATA SECTION

THE INFORMATION INDICATED BY THESE SHEETS SHALL BE COMPLETED DURING THE ACTUAL PERFORMANCE OF THIS TEST MEMORANDUM.

SHIP USS CAMBRIA (APA-36)

DATE 7/20/63 RECEIVER TYPE SRC-14 SERIAL NO. 15038

WEATHER CONDITIONS Clear

OPERATOR W. Bubeck & Stewart RECORDER McClenaghan

LOCATION Radio III STATION

RECEIVER NOISE LEVEL (DB) ANTENNA USED

FREQ. MC	RF GAIN SETTING	A BACKGROUND NOISE DB	B AREA INTER-FERENCE DB	C EQUIPMENT INTERFERENCE DB	D TOTAL INCREASE DB	REMARKS
38.5	FULL	0	-.5	.5	.5	
36.5	FULL	-.1	-.5	.5	.5	
33.5	FULL	-1	-.75	.25	.25	
31.5	FULL	-1	-8	-8	0	
29.7	FULL	-1	-2	-2	0	
27.5	FULL	-1	-2	-2	0	

ENCLOSURE (2)

SHIP TEST MEMORANDUM

ELECTRONIC INTERFERENCE TEST

RECORDED DATA SECTION

THE INFORMATION INDICATED BY THESE SHEETS SHALL BE COMPLETED DURING THE ACTUAL PERFORMANCE OF THIS TEST MEMORANDUM.

SHIP USS CAMBRIA (APA-36)
DATE 7/20/63 RECEIVER TYPE AN/SRR-11 SERIAL NO. 934
WEATHER CONDITIONS Humid
OPERATOR McGlenagham & Stewart RECORDER W. Bubeck
LOCATION Radio Central STATION

RECEIVER NOISE LEVEL (DB) ANTENNA USED

FREQ. KC	RF GAIN SETTING	A BACKGROUND NOISE DB	B AREA INTER-FERENCE DB	C EQUIPMENT INTERFERENCE DB	D TOTAL INCREASE DB	REMARKS
16.0	9.5	-10	+8	+8	+18DB	*
75.8	9.5	-10	+13	+13	+23DB	*
34.0	9.0	-10	+8	+8	+18DB	*
50.0	9.0	-10	+12	+12	+22DB	*
70.0	FULL	+6	+6	0	0	
118.0	FULL	+4	+5	+1	+1	
250.0	FULL	+1.5	0	0	0	
170.0	FULL	0	+1	+1	+1	
325.0	FULL	+3	+8	+5	+5	
450.0	FULL	+4	+6	+2	+2	
550.0	FULL	+1	+2	+1	+1	

* ATMOSPHERICS

(c) Demonstrate operation of all Key Control Stations by patching the TED-RED, in MCW operation, as indicated in Table ER-18c.

EVENT	ER-19	0800	IFF Equipment (a) Concurrent with air-search radar exercises: Demonstrate, in all modes, the response and coverage of the AN/UPX-1 identification set. Use the same flights of aircraft used in Event #17. Record all data in Table 19. (b) Record the maximum range observed during the trial. (c) Demonstrate the operation of the AN/UPX-12 by observing the operation of the "Interrogate" and "Reply" lights, and by use of the shipboard IFF test equipment. SIF?
EVENT	ER-20	1300	Demonstrate Troop Communications Equipment (a) TCS equipments were demonstrated in Event ER-5. (b) Demonstrate voice capabilities of each SRC Transmitter and Receiver by sequential patching utilizing LHMS-1 in Radio Central. Patch equipments as indicated on Table ER-20. Record results on Table ER-20.
EVENT	ER-21	1500	Demonstrate Portable Communications Equipment Demonstrate Portable Equipment within the ship. Demonstration of the survival radio equipment is mandatory. Care shall be exercised to insure that distress signals are not inadvertently transmitted outside the confines of the ship.
EVENT	ER-22		Demonstrate VHF & UHF Communications Back up if required. Same as Event ER-3.

APA36/9030/pn

(27er) Procure missing technical manuals and instruction sheets (BSTM 67-53)

(28er) Correct and resubmit Ship Electronic Installation Record NavShips 4110. (BSTM 67-114 and NavShips 900,135C)

(29er) Procure missing crystals to fill allowance as per BuShips Instr. 09670.58().

(30er) Procure and install interference filters IAW EIB 574.

(31er) Replace missing equipment identification labels in all electronic spaces.

(32er) Turn in radiac equipment for calibration and repair IAW current instructions.

(33er) Clean, represerve, and make light tight, the infrared searchlight filters.

(34er) Procure missing Maintenance Standards Books, NavShips 9xxxx.42 and Performance Standards Sheets, NavShips 9xxxx.32. (BSTM 67-54)

(35er) Procure and post at each operating position, Operating Instruction Charts, NavShips 9xxxx 21 or equivalent. (BSTM 67-54)

(36er) Complete establishing Reference Standards as preserved in applicable Maintenance Standards Book, Part I, and forward completed Reference Standards Summary Sheets (BSTM 67-54)

(37er) Properly install approved rubber deck matting in the following spaces: (BSTM 14-16 and 67-281)

Radio Central	Crypto Room
Chart House	

(38er) Inventory and replace missing test equipment accessories.

(39er) Procure missing allowance items including: (BuShips Instr. 4441.33c)

AN/GRC-37	3 AN/PDR-27J	11 IM-9()/PD
TCS mobile	4 AN/PDR-56	3 PP-354/PD
2 AN/PRC-10	6 CP-95/PD	
AN/CRT-3	12 IM-143/PD	
AN/URC-4	2 IM-153/PD	

APA36/9030/pn

(14er) Repair the following inoperative portable radio equipment:

(2) AN/PRC-9
(2) AN/PRC-10
AN/URC-4 serial 16442

(15er) Repair inoperative TCS #3, #6, and # 2.

(16er) Repair inoperative teletype machines:

(2) Model 14 Radio I
TTY #1
TTY #2
TTY #7

(17er) Repair the following inoperative AN/SRR-13A receivers: 1B, 1C, and 2A.

(18er) Procure services of qualified maintenance personnel and test operate KW-26.

(19er) Procure adequate supply of batteries for AN/URC-4 and SCR-536 transceivers.

(20er) Repair inoperative indicator lights in X-3/A infra red beacon.

(21er) Replace broken and missing radio telegraph keys in SACC.

(22er) Procure and permanently post approved waning signs in spaces and topside areas. (BSTM 67-284 and EIB 572)

(23er) Install grounded type a.c. service outlet boxes for test equipment and portable tools in the vicinity of electronics equipment. (BSTM 62-17)

(24er) Blank off or replace ungrounded a.c. service outlets installed in all electronics equipments. (BSTM 62-17)

(25er) Correct the following deficiencies throughout the installation:

a. Replace temporary labeling with permanent label plates.
b. Strap and clamp loose cabling.
c. Replace broken and missing meter glasses, captive screws, tube clamps and shields, indicator lamps and lens, and other hardware.

(26er) Identify and tag cabling to and associated with electronic equipment (BSTM 60-268)

DATE: 1 July 1964

ITEM NAME: RANGE-AZIMUTH INDICATOR

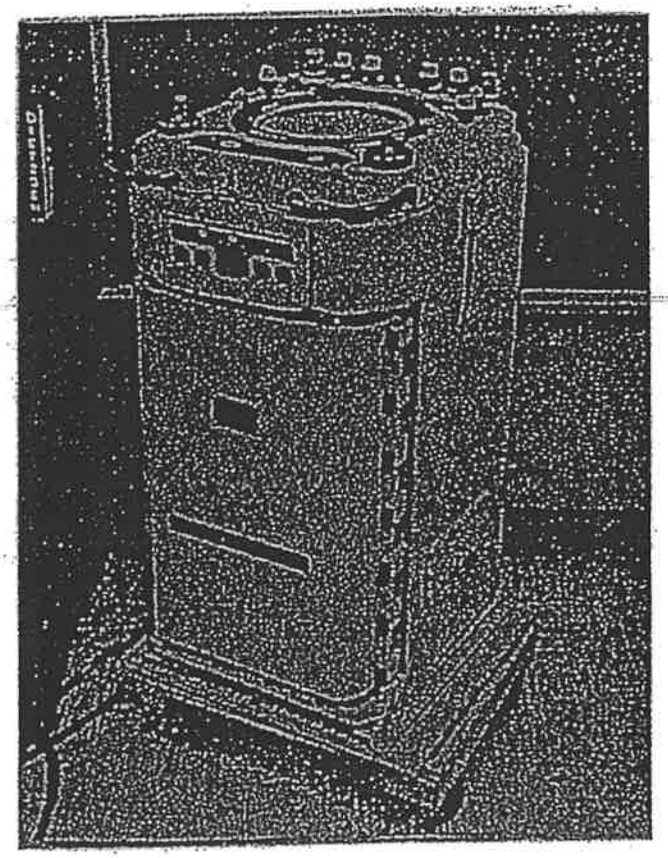
COGNIZANT SERVICE: USN

TYPE: AN/SPA-4, * -4A, ** -4B***

FEDERAL STOCK NUMBER: F5840-665-3686*
F5840-644-4626**
F5840-552-1903***

	USA	USN	USAF	USMC
Ltd Std*, ** STATUS OR TYPE CLASSIFICATION Sub .Std***				

General Electric Company*; Radio Corporation of America **;
Mfg(s) Name or Code Number: Bendix Aviation Corporation***



FUNCTIONAL DESCRIPTION

Range-Azimuth Indicators AN/SPA-4, -4A, and -4B provide PPI type presentations of target range and azimuth when supplied with video and trigger signals from any one of eight search radars. Azimuth is determined by means of a mechanical cursor. The target presentation is the result of two alternately generated electronic sweeps -- the PPI sweep and the cursor sweep. The PPI sweep is rotated through 360 degrees on the screen in synchronism with the associated radar antenna, and the cursor sweep traces a single, controlled radius. A spot-of-light range strobe appears on the screen during the cursor sweep and can be superimposed on any target in the PPI display, thus permitting a highly accurate measurement of the target range. Field changes to the AN/SPA-4 and AN/SPA-4A provide an indication of true bearing which is incorporated in the design of the AN/SPA-4B.

RELATION TO SIMILAR EQUIPMENT

None.

TECHNICAL DESCRIPTION

Video Input:
- AN/SPA-4 - +1 to +2.5v
- AN/SPA-4A, -4B - +2 ±0.5v

Trigger Input: +5 to +50v

Pulse Repetition Rate:
- AN/SPA-4 - 140 to 3, 000 pps
- AN/SPA-4A, -4B - 60 to 3, 000 pps

Operating Voltages and Power Requirements:
- AN/SPA-4 - 115v ±10%, 60 ±2 cps, 1-ph, 14.2 amp, 97% pf, 715 va, 690w
- AN/SPA-4A, -4B - 115v ±10%, 60 cps, 1-ph, amp ±10%, 90% pf, 1, 110 va

Type of Presentation: One 10-in. PPI

Range Marks:
- AN/SPA-4 - 0.5, 1, 5, 20, and 50 mi
- AN/SPA-4A, -4B- 0.5, 1, 2, 5, 10, 20, and 50 mi

AN/SPA-4, -4A, -4B

Range Strobe Accuracy: ±1% of range scale
Azimuth Accuracy: 2 deg for 1-speed; 1 deg for 1- and 36-speed
Sweep Accuracy: ±1% from 1- to 20-mi range; ±2% from 20- to 250- or 300-mi range

INSTALLATION CONSIDERATIONS

Siting: If open bridge or weather exposed site is used, Air Exchange Valve MX- 1478/SPA-4A is needed.
Vertical Mounting: Bottom shock mounts must be bolted to a horizontal deck or surface. If practical, further secure equipment to bulkhead by means of two shock mounts at the upper rear of the unit.
Tilted Mounting: As much as 45 deg forward slanting allowed. Equipment must be permanently attached to a support tilted the same angle as the equipment.
Cabling Requirements: Video and trigger cables must have a characteristic impedance of 75 ohms. The rear cable entrance hole is not available when Air Exchange Valve MX- 1478/SPA-4A is used.
Related Equipment: Designed for use with any standard Navy search radar system having a prf between 140 and 3, 000 pps.

PRINCIPAL COMPONENTS AND PHYSICAL DATA

COMPONENT	QTY	HEIGHT (Inches)	WIDTH (Inches)	DEPTH (Inches)	UNIT WT. (Pounds)
Range-Azimuth Indicator ID-302/SPA-4	1	37-15/16	21-3/4	18	342
Range-Azimuth Indicator AN/SPA-4A	1	38	21	19	366
Range-Azimuth Indicator AN/SPA-4B	1	39	21	19	400

REFERENCE DATA AND LITERATURE

Technical Manuals:
- NAVSHIPS 91659
- NAVSHIPS 91825(B)
- NAVSHIPS 92942(A)

NAVSHIPS 91825.42 *Non-Registered*

"APPROVED MANUSCRIPT"

MAINTENANCE STANDARDS BOOK

for

RANGE-AZIMUTH INDICATOR

AN/SPA-4A

SERIAL NO.________

RCA SERVICE COMPANY

GOVERNMENT SERVICE DEPARTMENT

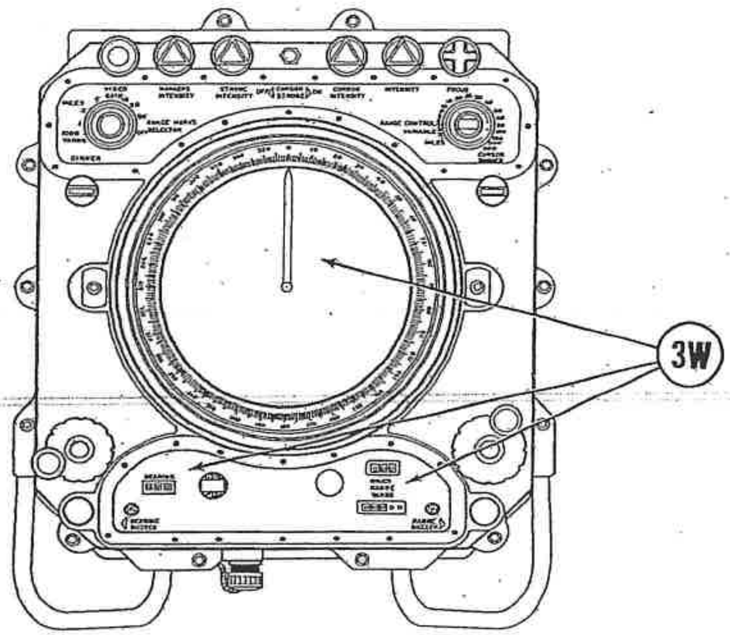
CAMDEN, NEW JERSEY

DEPARTMENT OF THE NAVY

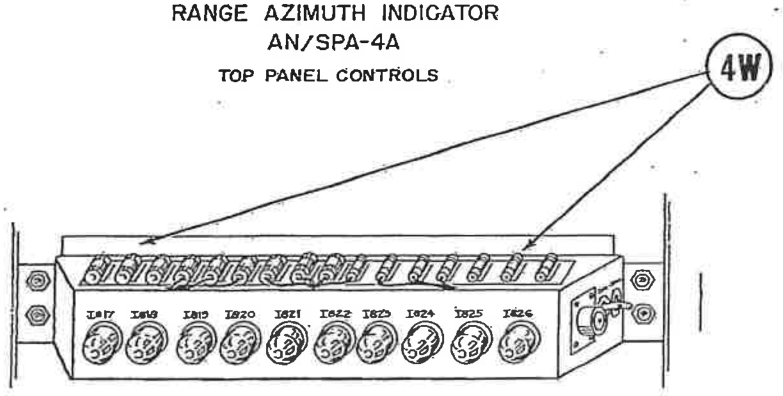
BUREAU OF SHIPS

Contract: NObsr 71524 Approved by BuShips: 26 January 1959

STEPS 3W AND 4W



RANGE AZIMUTH INDICATOR
AN/SPA-4A
TOP PANEL CONTROLS



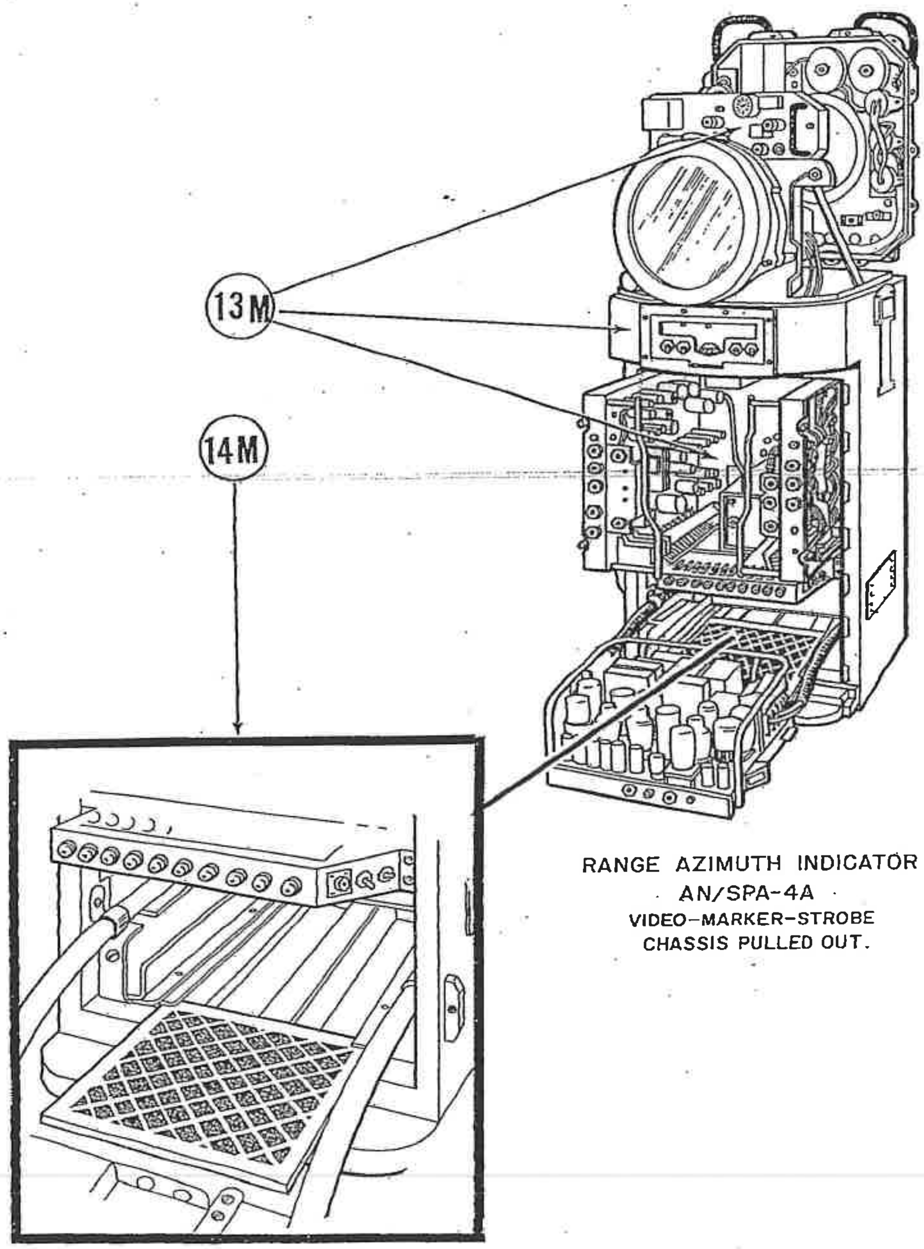
FUSE LOCATIONS

O. M. Designates
Operational Maintenance

AN/SPA-4A with EXTERNAL POWER switch (S-816): OFF

STEP NO.	ACTION REQUIRED	PROCEDURE
3W O. M.	Clean the light filters, cursor and windows over the counter dials.	The light filters, cursor and windows are made of transparent plastic (Lucite). Be careful not to scratch the surfaces. Use a clean, soft cloth with Permay #246 Plasticlean compound. DO NOT use water or a wet rag.
4W O. M.	Check the control knobs and spare fuses.	Tighten all loose control knobs. See that the spare fuses are in the proper place and are in good condition.
		NOTE The charts for steps 3W and 4W appear on page 2-24.

STEPS 13M AND 14M



RANGE AZIMUTH INDICATOR
AN/SPA-4A
VIDEO-MARKER-STROBE
CHASSIS PULLED OUT.

REMOVAL OF AIR FILTER

AN/SPA-4A with EXTERNAL POWER switch (S-816): OFF

STEP NO.	ACTION REQUIRED	PROCEDURE
13M	Clean the inside and outside of the equipment.	Clean the inside and outside of the AN/SPA-4A with a clean, soft, dry cloth, using a bellows or a vacuum cleaner where necessary.
14M	Clean the air filter.	Remove the Power Supply chassis and loosen the four machine screws holding the filter in place. Slide the filter out. Wash the filter in a hot water solution of dishwashing compound or other approved Navy solvent. Dry throughly. Dip the filter in light engine oil, let drain and replace.

STEP NO.													
	Month												
13M	Initial												
	Date												
14M	Initial												
	Date												

STEP NO.													
	Month												
13M	Initial												
	Date												
14M	Initial												
	Date												

AN/SPA-4A with EXTERNAL POWER switch (S-816): OFF

STEP NO.	ACTION REQUIRED	PROCEDURE
2S	Inspect all gears.	Inspect the gears and all friction surfaces for excessive wear or complete dryness. This equipment has been properly lubricated at the factory. Under normal conditions, oiling will not be necessary during the life of the equipment since oil-impregnated bearings are used. Should extraordinary conditions develop making it necessary to lubricate the elements of the unit, sparingly apply a fine medium oil to all bearings (except the oil-impregnated) with a drop stick. When abnormal conditions make it necessary to lubricate the gear trains, apply a thin coating of a non-fluid grease. Be sure that no grease comes in contact with the electrical components of the equipment.

STEP NO.	1st HALF		2nd HALF		3rd HALF		4th HALF	
	Initial	Date	Initial	Date	Initial	Date	Initial	Date
2S								

U.S. GOVERNMENT PRINTING OFFICE: 1959 O - 516343

NAVSHIPS 91411.41

Non-Registered

"APPROVED MANUSCRIPT"

MAINTENANCE CHECK-OFF BOOK

for

INDICATOR GROUP
AN/SPA-8, AN/SPA-8A, AN/SPA-9

MODEL NO.________

SERIAL NO.________

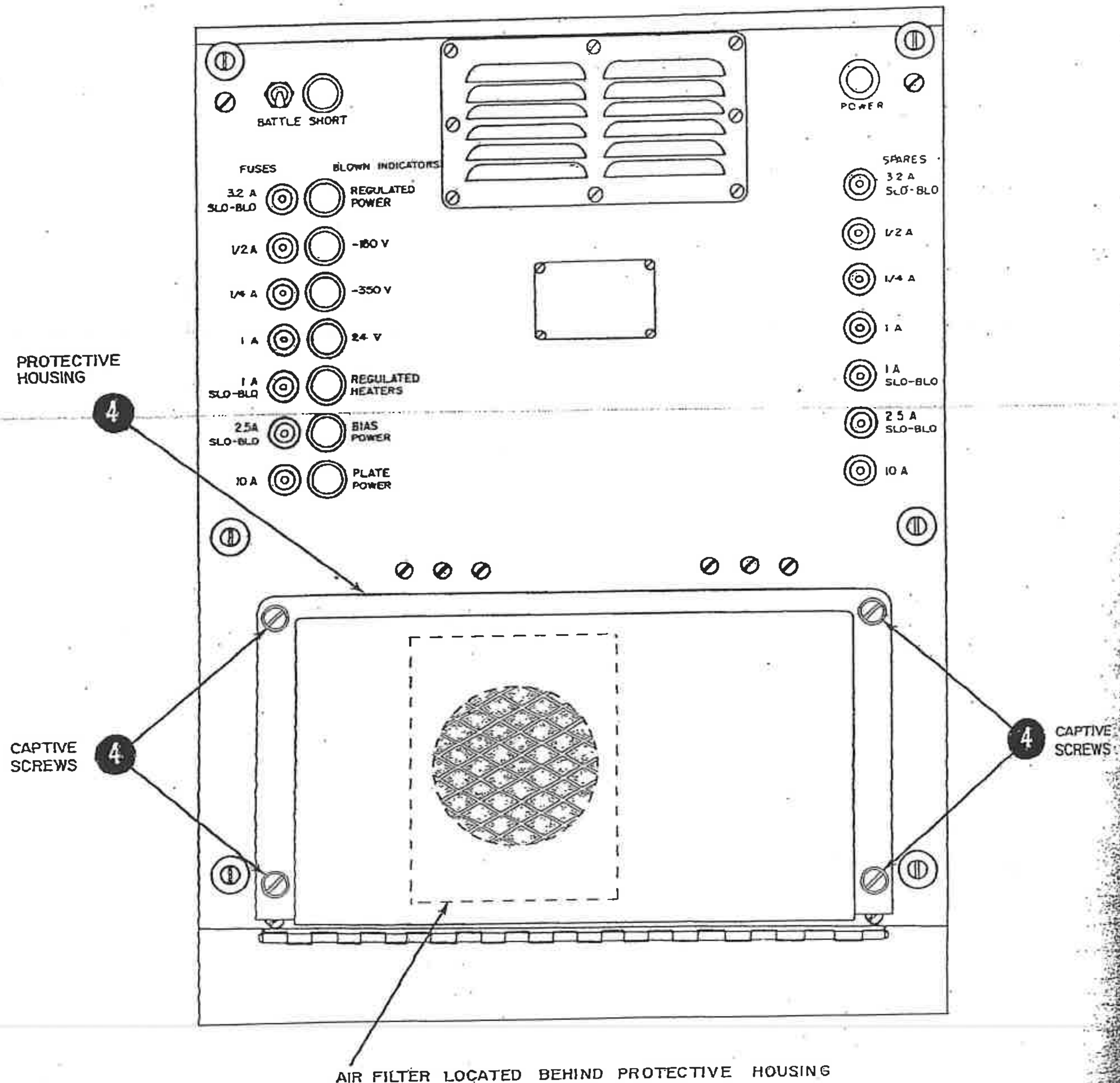
RCA SERVICE COMPANY, INC.
GOVERNMENT SERVICE DEPARTMENT
CAMDEN, NEW JERSEY

DEPARTMENT OF THE NAVY
BUREAU OF SHIPS

Contract: NObsr 63505

Approved by BuShips: 22 June 1954

POWER SUPPLY



WARNING

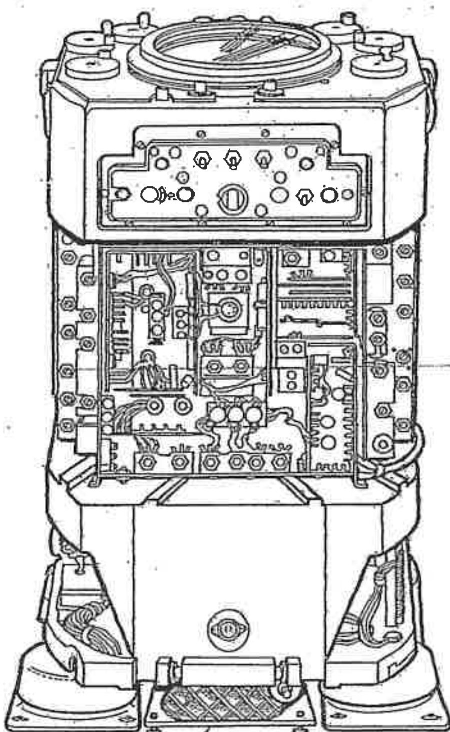
BEFORE ATTEMPTING TO REMOVE THE AIR FILTER IN THE POWER SUPPLY, FIRST MAKE SURE THAT THE POWER SWITCH IS IN THE OFF POSITION. WITH THE FILTER REMOVED, THE BLADES OF THE BLOWER FAN ARE EXPOSED.

Indicator Group POWER switch: OFF position.

STEP NO.	ACTION REQUIRED	PROCEDURE
4	Clean Power Supply air filter.	Remove protective housing by loosening the four captive screws. Remove filter. (If it is not readily removable, it may be pushed out from rear of panel.) Clean filter with hot water solution of Dishwashing Compound (SNSN G51-C-1576-100). Dry filter thoroughly. Add two or three drops of fine grade instrument oil, conforming to Spec 14-0-20 (Ord) on filter grid and spread around by means of an air hose. Use no more oil than prescribed; excess will be drawn into equipment by the blower. Replace filter making sure that it is properly seated before replacing the protective housing.

	JAN 19__	FEB 19__	MAR 19__	APR 19__	MAY 19__	JUNE 19__	JULY 19__	AUG 19__	SEPT 19__	OCT 19__	NOV 19__	DEC 19__
Week	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial
1												
2												
3												
4												
5												

AZIMUTH RANGE INDICATOR
FRONT PANEL REMOVED



KNURLED CAPTIVE SCREW 17

17 KNURLED CAPTIVE SCREW

17 FRONT OF FILTER COVER HINGED DOWN

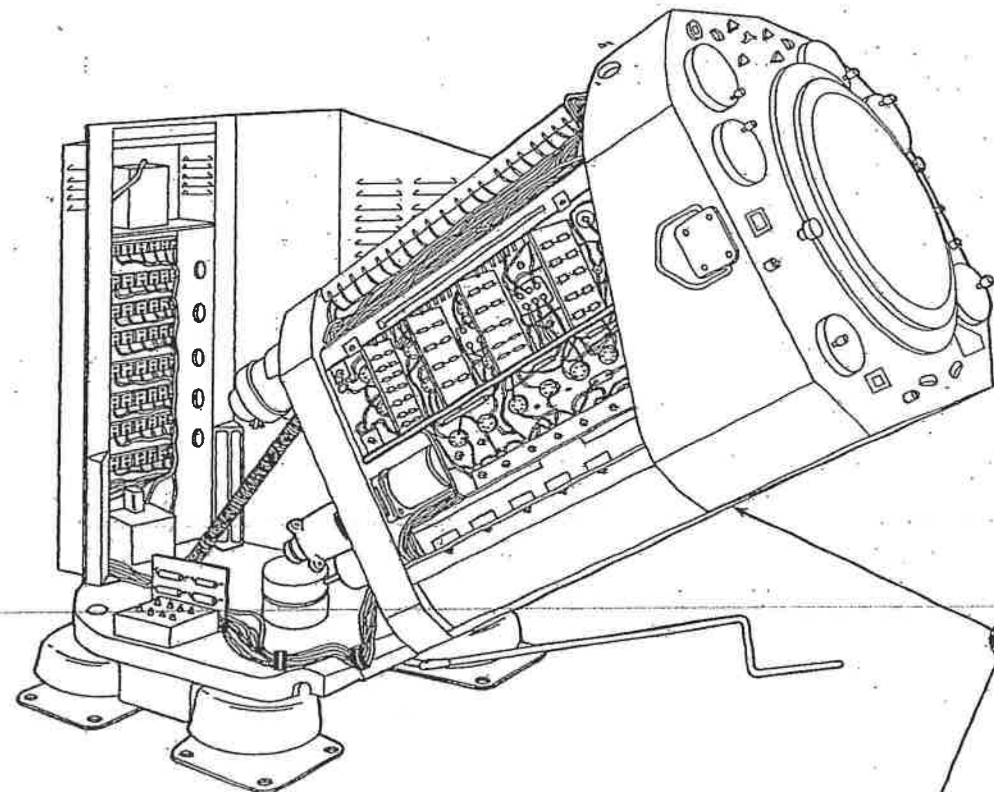
WARNING
BEFORE ATTEMPTING TO REMOVE THE AIR FILTER IN THE INDICATOR, FIRST MAKE SURE THAT THE POWER SWITCH IS IN THE OFF POSITION. WITH THE FILTER REMOVED, THE BLADES OF THE BLOWER FAN ARE EXPOSED.

Indicator Group in TEST OPERATION.
POWER switch: OFF position.

STEP NO.	ACTION REQUIRED	PROCEDURE
17	Clean Indicator air filter.	Remove front panel of Indicator. Reach up under the base of Indicator, from the front, and locate two knurled captive screws. Loosen both screws. The front of the hinged filter cover will then drop down. Remove filter. Clean filter with hot water solution of Dishwashing Compound (SNSN G51-C-1576-100). Dry filter thoroughly. Add two or three drops of fine grade instrument oil, conforming to Spec 14-0-20 (Ord), on filter grid and spread around by means of an air hose. Use no more oil than prescribed; excess will be drawn into equipment by blower. Replace filter making sure that it is properly seated before raising hinged filter cover in place. Replace front panel.
18	Inspection of controls.	Examine knobs on all controls. Replace if broken. Tighten if necessary.

STEP 17	JAN 19__	FEB 19__	MAR 19__	APR 19__	MAY 19__	JUNE 19__	JULY 19__	AUG 19__	SEPT 19__	OCT 19__	NOV 19__	DEC 19__
Week	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial
1												
2												
3												
4												
5												

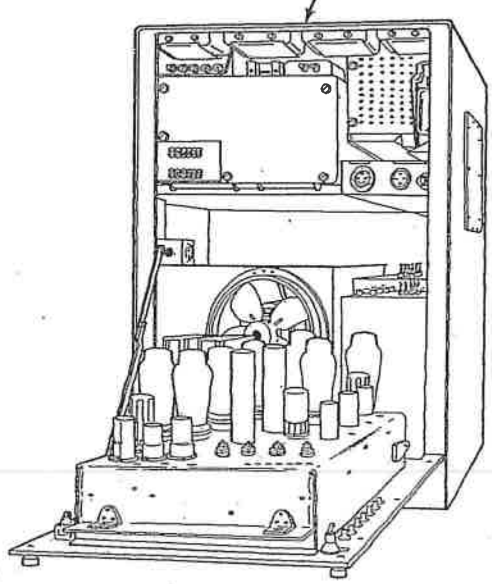
STEP 18	JAN 19__	FEB 19__	MAR 19__	APR 19__	MAY 19__	JUNE 19__	JULY 19__	AUG 19__	SEPT 19__	OCT 19__	NOV 19__	DEC 19__
Week	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial	Initial
1												
2												
3												
4												
5												



13

AZIMUTH-RANGE INDICATOR
TILTED FORWARD

WARNING
MAKE SURE THAT THE EXTERNAL SUPPLY SWITCH IS OFF.



POWER SUPPLY
FRONT HINGED DOWN

AN/SPA-8, AN/SPA-8A,
AN/SPA-9

MONTHLY
STEP 13
ROUTINE

WARNING

MAKE SURE THE EXTERNAL SUPPLY SWITCH IS OFF.

External supply switch, located ______________ to off position.

STEP NO.	ACTION REQUIRED	PROCEDURE
13	Clean equipment.	Clean the inside and outside of Indicator and Power Supply thoroughly.

CAUTION

EXAMINE SURFACES FOR DUST AND DIRT PARTICLES BEFORE CLEANING. DO NOT RUB DUST AND DIRT, BUT RINSE OFF. DO NOT USE AN ABRASIVE SOAP OR CLEANING COMPOUND. WIPE GENTLY WITH A CLEAN SOFT CLOTH. USE EXTREME CARE WHEN CLEANING INSIDE OF INDICATOR AND POWER SUPPLY TO AVOID DAMAGING ELECTRICAL COMPONENTS, TUBES, WIRE CONNECTIONS, ETC.

STEP NO.	Month	JAN 19__	FEB 19__	MAR 19__	APR 19__	MAY 19__	JUNE 19__	JULY 19__	AUG 19__	SEPT 19__	OCT 19__	NOV 19__	DEC 19__
13	Initial												
	Date												

DATE: 1 July 1964

ITEM NAME: TRANSPONDER SET

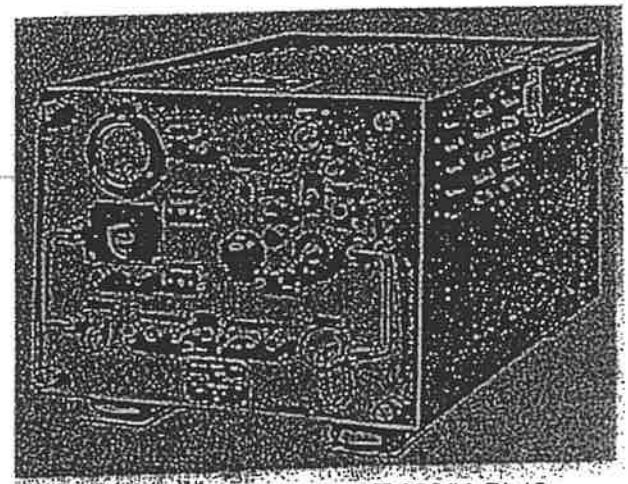
COGNIZANT SERVICE: USN

TYPE: AN/UPX-12, * -12A, ** -12B***

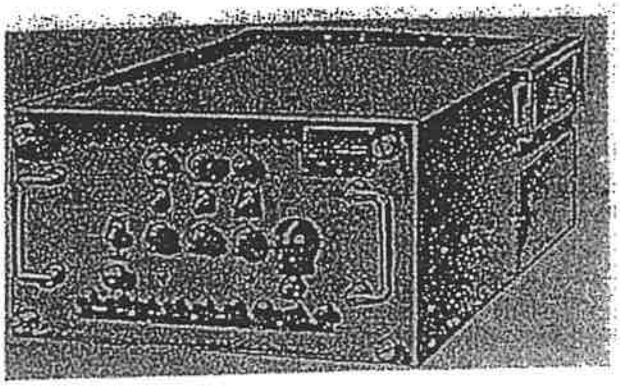
FEDERAL STOCK NUMBER:

	USA	USN	USAF	USMC
STATUS OR TYPE CLASSIFICATION		Sub. Std		

Mfg(s) Name or Code Number: General Electric Company*; Radio Receptor Company, Inc.**



Receiver-Transmitter RT-38?()/uPI-12



Decoder KT-200()/UPY-12

FUNCTIONAL DESCRIPTION
Transponder Sets AN/UPX-12, -12A, and -12B respond to appropriate interrogations from Radar Recognition Sets for the purpose of self-identification. They receive paired-pulse interrogation signals and transmit single-pulse identifying replies. Interrogations are pulse-pairs in one or more of three modes as determined by the spacing of the pulses in a pair. Replies to all modes are single, one-microsecond pulses.

RELATION TO SIMILAR EQUIPMENT
Similar to the AN/UPX-5, -5A, and -5B equipments.

TECHNICAL DESCRIPTION
Frequency: Receiver, 1010 to 1030 mc; transmitter, 1090 to 1110 mc
IF. Frequency: 59.5 +1.5 mc
Bandwidth: 8 to 11 mc at 6 db down
Duty Cycle: 0.1% while carrying pulses of 10-kw peak power
Minimum Output: 300w at 500 pps
Pulse Width: 0.9 to 1.3 -sec (50% of peak amplitude)
Operating Voltages and Power Requirements: 105 to 125v, 57 to 63 cps or 360 to 440 cps, 1-ph, 398w approx

INSTALLATION CONSIDERATIONS
Siting:
Mounting:
Cabling Requirements: Cables must enter the cases without sharp bends. Interconnecting cables between receiver-transmitter and decoder must not exceed 20 feet. The antenna cable must not exceed 150 feet and other cables should not exceed 300 feet in length.
Related Equipment:

AN/UPX-12, -12A, -12B

PRINCIPAL COMPONENTS AND PHYSICAL DATA

COMPONENT	QTY	HEIGHT (Inches)	WIDTH (Inches)	DEPTH (Inches)	UNIT WT. (Pounds)
AN/UPX- 12					
Receiver-Transmitter RT-387/UPX- 12	1	15-1/2	18	28-3/8	141
Decoder KY-200/UPX-12	1	10	18	26-5/8	101
Video Coder KY-136/UPA-38	1				
Radar Set Control C-1047/UPA-38	1				
AN/UPX- 12A					
Receiver-Transmitter RT-387A/UPX- 12	1				
Decoder KY-200A/UPX-12	1				
Video Coder KY-136/UPA-38	1				
Radar Set Control C- 1047/UPA-38	1				
AN/UPX- 12B					
Receiver-Transmitter RT-387B/UPX-12	1				
Decoder KY-200B/UPX-12	1				
Video Coder KY-136/UPA-38	1				
Radar Set Control C-1047/UPA-38	1				

REFERENCE DATA AND LITERATURE

Technical Manual:
NAVSHIPS 92820

NAVSHIPS 92441.42

Non-Registered

"APPROVED MANUSCRIPT"

MAINTENANCE STANDARDS BOOK

for

RADIO SETS AN/SRC-13, -14, -15

SERIAL NO. ________

OF MODEL ________

RCA SERVICE COMPANY

GOVERNMENT SERVICE DEPARTMENT

CAMDEN, NEW JERSEY

DEPARTMENT OF THE NAVY

BUREAU OF SHIPS

Contract: NObsr 71524 *Approved by BuShips: 28 May 1958*

STEP 21Q

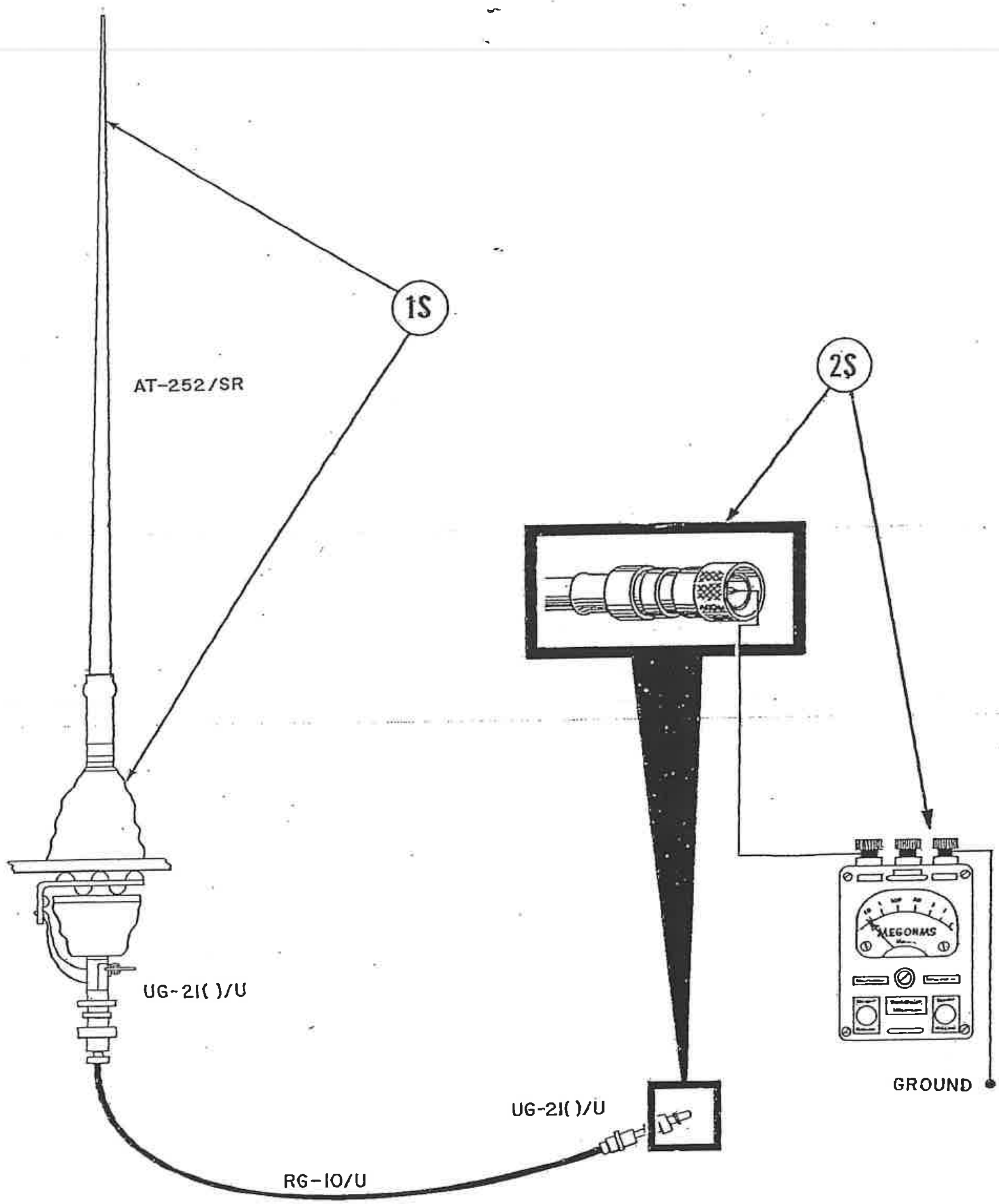
AN/SRC Completely De-energized.

STEP NO.	ACTION REQUIRED	PROCEDURE
21Q	Inspect the equipment for mechanical faults.	Inspect the ground clamp and ground straps for clean, tight connections. Clean and tighten cup insulators and bushings. Inspect the operation of the shock mounts. Inspect cables, plugs, connectors and receptacles for cracked or defective insulation. Straighten cable kinks and remove improper supports. Inspect the terminal boards (including terminal boards in junction box of mounting MT-327/GR, MX-1583/SRC (if used) and Control Box C-375/VRC). Clean corroded connections with crocus cloth. Inspect all switches for proper action, evidence of arcing and tight connections. Inspect all potentiometers for broken parts, loose connections and loose or missing control knobs. Inspect the mechanical tuning and detent assemblies for loose or broken parts and for dirt, rust or corrosion. Clean, tighten and replace all defective parts.

STEP NO.	1st QUARTER		2nd QUARTER		3rd QUARTER		4th QUARTER	
	Initial	Date	Initial	Date	Initial	Date	Initial	Date
21Q								

STEP NO.	5th QUARTER		6th QUARTER		7th QUARTER		8th QUARTER	
	Initial	Date	Initial	Date	Initial	Date	Initial	Date
21Q								

STEP (1S)



O.M. - Designates Operational Maintenance

STEP NO.	ACTION REQUIRED	PROCEDURE
1S O.M.	Inspect and clean the Antenna mast section and base.	Unscrew the mast section from the mast base. Clean each mast section and antenna cup insulators with soap and water. Remove all salt and soot deposits, rinse with clear water and dry thoroughly. Inspect the mast section for rust and corrosion, particularly at the threaded connector. Remove all foreign material with crocus cloth or by careful scraping. Remove the ground strap and the ground clamp at the Antenna cup insulator. Clean and replace parts as necessary for a clean, tight connection. Inspect the cable connector at the Antenna base. Remove all foreign matter that would prevent a good electrical connection.

STEP NO.	1st HALF		2nd HALF		3rd HALF		4th HALF	
	Initial	Date	Initial	Date	Initial	Date	Initial	Date
1S								

NAVSHIPS 91420.41

Non-Registered

"APPROVED MANUSCRIPT" MAINTENANCE CHECK-OFF BOOK *for* SONAR SOUNDING SETS AN/UQN-1B, AN/UQN-1C

MODEL NO.________

SERIAL NO.________

RCA SERVICE COMPANY, INC.
GOVERNMENT SERVICE DEPARTMENT
CAMDEN, NEW JERSEY

DEPARTMENT OF THE NAVY
BUREAU OF SHIPS

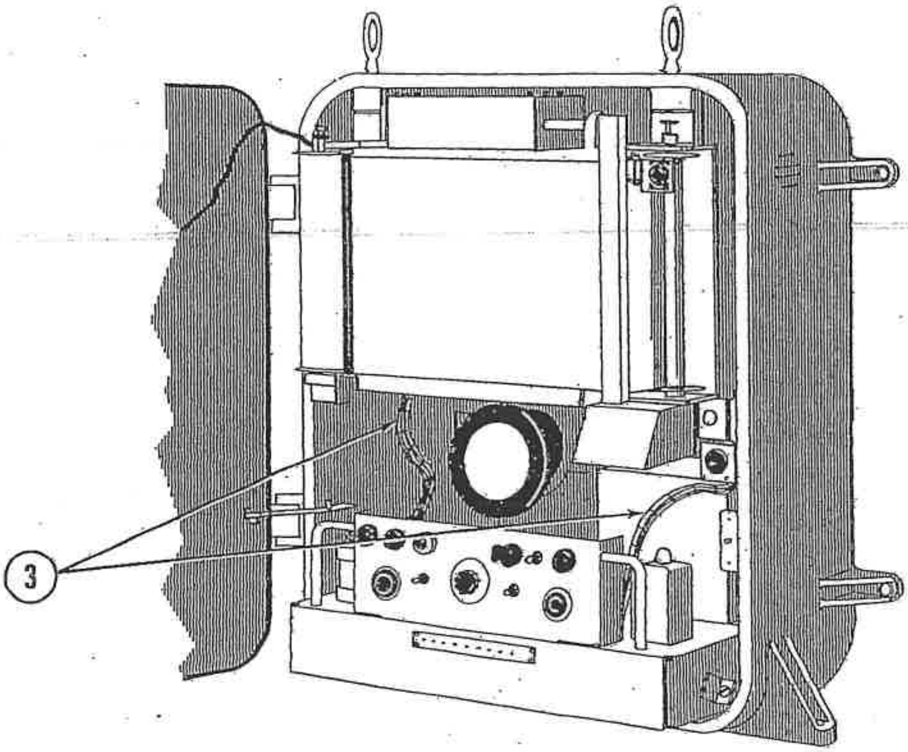
Contract: NObsr 63505

Approved by BuShips: 6 September 1955

MONTHLY
STEPS (1) THRU (3)

(1) CLEAN EQUIPMENT

(2) INSPECT ALL CONTROLS



SONAR SOUNDING SET
CABINET DOOR OPEN

Sonar Sounding Set de-energized
Front cover open

STEP NO.	ACTION REQUIRED	PROCEDURE
1	Clean equipment.	Clean inside of cabinet with vacuum cleaner. Withdraw and invert Receiver-Indicator chassis and vacuum. All dirt must be removed from switches, terminal boards, and tube sockets. If all dirt cannot be removed by vacuuming use dry brush to loosen or remove deposits. Any remaining deposits are best removed with a clean lint-free cloth which has been moistened with Dry Cleaning Solvent 140-F Fed. Spec. P-S-661 type II (5 gal; SNSN G51-S-4718-10). Corrosion must be removed whenever it becomes evident. Connectors, terminals, jacks, etc. can be polished with crocus cloth or #0000 sandpaper in especially stubborn cases.
2	General mechanical inspection.	Visually inspect the mechanical action of all controls. Clean with Dry Cleaning Solvent 140-F Fed. Spec. P-S-661 type II (5 gal; SNSN G51-S-4718-10) if sticking occurs. Check that all mountings and connections are tight. All shafts should rotate freely. All switches must be inspected for damage due to arcing. When it is necessary to burnish contacts use a burnishing tool.
3	General electrical inspection.	Note and replace charred wiring, burnt or discolored resistors, and bulged or broken capacitors. Inspect all cables and wiring for frayed, cut, deteriorated or cracked insulation, kinks or strains.

STEP NO.	Month	JAN 19__	FEB 19__	MAR 19__	APR 19__	MAY 19__	JUNE 19__	JULY 19__	AUG 19__	SEPT 19__	OCT 19__	NOV 19__	DEC 19__
1	Initial												
	Date												
2	Initial												
	Date												
3	Initial												
	Date												

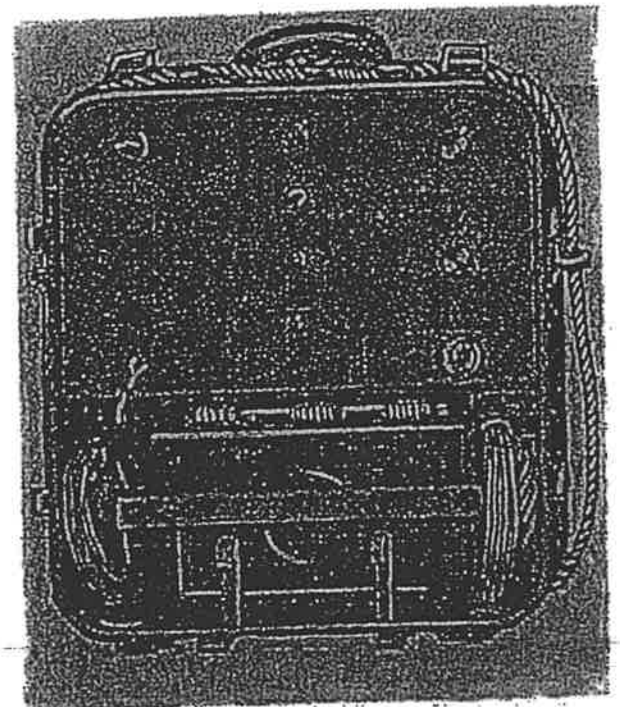
UNCLASSIFIED

April 1958

Radio-Transmitters

RADIO TRANSMITTING SET

AN/SRT-1



Radio Transmitting Set AN/SRT-1

FUNCTIONAL DESCRIPTION

The AN/SRT-1 is a portable fixed-frequency battery-operated lifeboat transmitter. It transmits automatically for a period of two minutes each time the button is pressed and then automatically stops to conserve the battery. The set is housed in a watertight case. During each two minute period, the SOS distress signal is sent 18 times, and long dashes are also sent 6 times to facilitate the taking of bearings by rescue ships. The sending of the above signals does not require an operator, but a hand telegraph key is provided for use by a radio operator in the transmission of A2 messages. The included battery has life of 96 minutes, or is good for 48 of the 2 minute message cycles. This will be sufficient for 48 hours if the unit is used only on the hour, as recommended.

A battery charging panel (Radiomarine Corp of America Model RM-16) consisting of an ammeter and current limiting resistors is used to charge the transmitter storage battery from the 115 v, DC ship mains.

No field changes in effect at time of preparation (28 March 1958).

RELATION TO OTHER EQUIPMENT

The AN/SRT-1 is identical to Radiomarine Corp of America Emergency Transmitter Model ET-8026.

ELECTRICAL AND MECHANICAL CHARACTERISTICS

FREQUENCY RANGE: 500 kc international distress frequency.
FREQUENCY CONTROL: Designed for single frequency only.
TYPE OF EMISSION: A1 (automatic keying) or A2 (hand keying).
POWER OUTPUT: 5 W.
RANGE: 50 to 100 mi.
POWER REQUIREMENTS: 6 v storage battery, self-contained.
ANTENNA: Equipment has wire antenna attached for lifeboat use.

MANUFACTURER'S OR CONTRACTOR'S DATA

Radiomarine Corp of America, New York, N.Y.

TUBE AND/OR CRYSTAL COMPLEMENT

(2) 1624
Total Tubes: (2)

No Crystals Used.

REFERENCE DATA AND LITERATURE

TM 11-487A: Directory of Signal Corps Radio Communication Equipment.

TYPE CLASSIFICATION
DESIGN COGNIZANCE TASSA
PROCUREMENT COGNIZANCE
STOCK NO.

EQUIPMENT SUPPLIED DATA

QUANTITY PER EQUIPT	NAME AND NOMENCLATURE	OVERALL DIMENSIONS (Inches)	WEIGHT (lbs.)
1	Radio Transmitting Set AN/SRT-1 including:	13-1/2 x 15-13/16 x 21-11/16	60
1	Battery Charging Panel (RMCA Model RM-16)		

UNCLASSIFIED

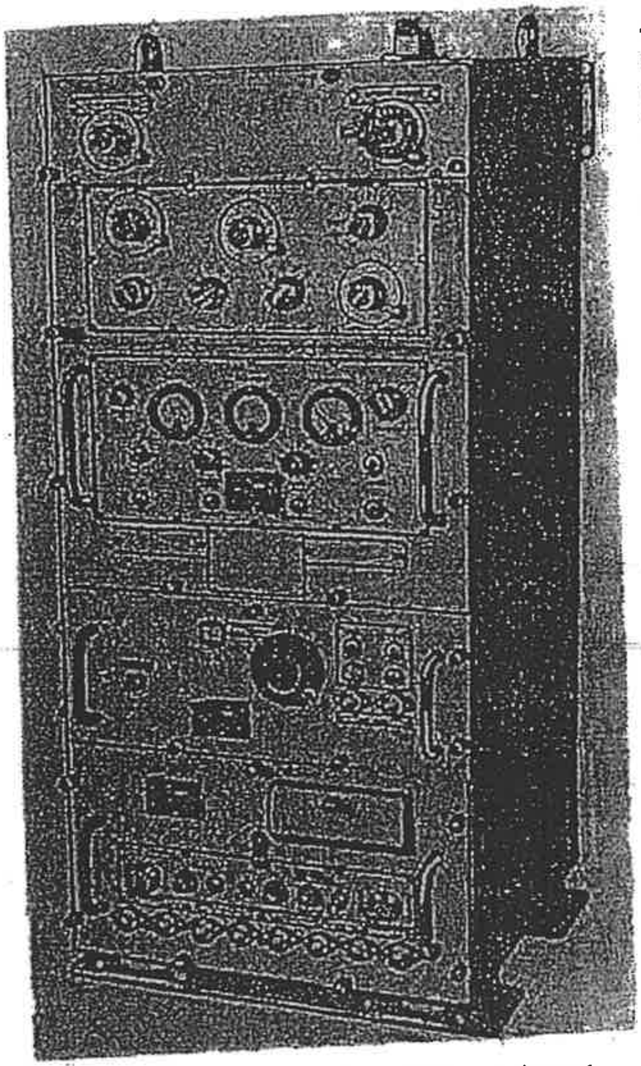
UNCLASSIFIED

January 1958

Radio-Transmitters

TRANSMITTING SET, RADIO

AN/SRT-17(XN-1)



Transmitting Set, Radio AN/SRT-17(XN-1)

FUNCTIONAL DESCRIPTION

The AN/SRT-17(XN-1) is intended for general purpose use aboard ship and at shore installations under widely varying climatic conditions. It provides a complete radio transmitting facility with the exception of antenna, power source, keying and phone equipment. The equipment is designed for operation into an antenna having a radio frequency resistance between 5 and 1800 ohms and a reactance from +2000 to −2000 ohms.

The transmitter may be operated from a remote location with the use of a standard "6 wire" remote unit. A telephone jack is also provided for use with a receiver monitor/headset.

No field changes in effect at time of preparation (30 April 1957).

RELATION TO OTHER EQUIPMENT

Similar to but not interchangeable with Radio Transmitting Set AN/URT-12.

Equipment Required but not Supplied: (1) Suitable Antenna, Keying and phone equipment.

ELECTRICAL AND MECHANICAL CHARACTERISTICS

EMISSION: CW and voice.
FREQUENCY RANGE: 2 to 30 mc.
NUMBER OF BANDS: 9.
FREQUENCY CONTROL: Master oscillator.
POWER OUTPUT
A1 EMISSION: 100 W.
A3 EMISSION: 75 W.
POWER SOURCE REQUIRED: 115 or 230 v, 50 to 60 cycle, single ph.

MANUFACTURER'S OR CONTRACTOR'S DATA

Radiomarine Corp of America, New York, N. Y.
Contract NObsr-63313.

TUBE AND/OR CRYSTAL COMPLEMENT

(2) 5R4WGXB
(2) 3B28
(1) 12AT7WA
(4) 6AG7
(1) 6BG6G
(2) 5814A
(1) 5R4WGB
(3) 12AX7
(4) 4-65A
(1) 807
(1) 6AQ5W
(2) OA2WA
Total Tubes: (24)
(1) CR-18/U
Total Crystals: (1)

REFERENCE DATA AND LITERATURE

Technical Manual for Radio Transmitting Set AN/SRT-17(XN-1).

TYPE CLASSIFICATION	
DESIGN COGNIZANCE	BUSHIPS
PROCUREMENT COGNIZANCE	
STOCK NO.	

UNCLASSIFIED

UNCLASSIFIED

January 1958

Radio-Transmitters

AN/SRT-17 (XN-1) TRANSMITTING SET, RADIO

SHIPPING DATA

NUMBER OF BOXES	CONTENTS AND IDENTIFICATION	VOLUME (Cu.Ft.)	OVERALL DIMENSIONS (Inches)	WEIGHT PACKED (lbs.)
1	Radio Transmitting Set Incl 2 Technical Manuals and test cables AN/SRT-17(XN-1)			
1	Set of Spares			

EQUIPMENT SUPPLIED DATA

QUANTITY PER EQUIPT	NAME AND NOMENCLATURE	OVERALL DIMENSIONS (Inches)	WEIGHT (lbs.)
1	Radio Transmitting Set AN/SRT-17(XN-1) C/O	21-1/2 X 23 X 48	418
	(1) Electrical Equipment Cabinet CY-1778(XN-1)/SRT-17	20-1/8 X 21-1/2 X 48	
	(1) Power Supply PP-1294(XN-1)/SRT-17	11 X 19-5/8 X 20	
	(1) Radio Frequency Oscillator O-332(XN-1)/SRT-17	7-7/8 X 9-7/8 X 19-5/8	
	(1) Radio Transmitter T-557(XN-1)/SRT-17	9-5/8 X 20-1/4 X 29-1/8	
	(1) Set of Spares		
	(2) Technical Manuals		4
	(1) Set of Test Cables		10

UNCLASSIFIED

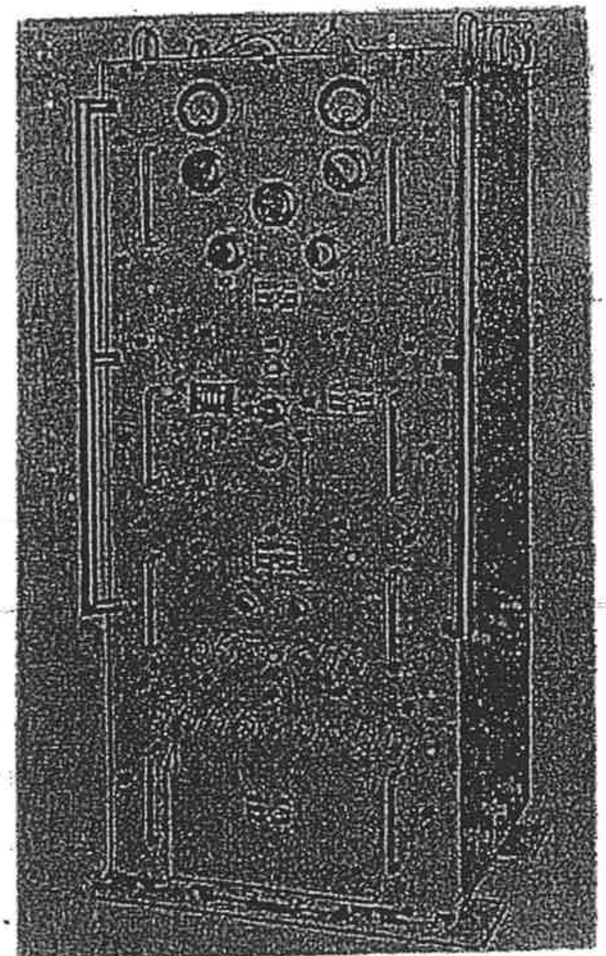
UNCLASSIFIED

August 1957

Radio-Transmitters

AN/URT-13

RADIO TRANSMITTING SET



Radio Transmitting Set AN/URT-13

FUNCTIONAL DESCRIPTION

The AN/URT-13 is intended for use on Coast Guard vessels and at Coast Guard radio communication shore stations under widely varying climatic conditions. It provides a complete radio transmitting facility with the exception of antenna, power source, channel frequency crystals and keying equipment. The transmitter has been designed to operate at ambient temperatures between 0 deg to 55 deg C and in a relative humidity up to 95%.

No field changes in effect at time of preparation (27 November 1956).

RELATION TO OTHER EQUIPMENT

Equipment Required but not Supplied: (As required) Crystal CR-25/U, (1) Antenna, (1) Remote Control Unit 23211, (1) Remote Control Cable MHFA-7, (1) Automatic Keyer, (1) Frequency Meter, (1) Power Cable DHFA-9.

ELECTRICAL AND MECHANICAL CHARACTERISTICS

FREQUENCY RANGE: 239 to 556 kc.
TYPE FREQUENCY CONTROL: Crystal or master oscillator.
NUMBER CRYSTAL CHANNELS: 4.
TYPE M O CONTROL: Manual, continuously variable over entire range in three bands.
TYPE EMISSION: A1, A2.
MODULATION FREQUENCY: 1000 cps, −10 to +20%.
MODULATION CAPABILITY: 100%.
KEYING TYPE: On-off (electron tube).
KEYING SPEED
CW: Up to 100 wpm.
MCW: Up to 60 wpm; keys carrier and modulation.
CONTROL: Local or remote start-stop and keying, manual or automatic.
RF OUTPUT: 200 W, 4 ohms, 750 mmf.
SPURIOUS RADIATION: 50 db min. below carrier.
HUM LEVEL: Less than 1% of value equivalent to 100% modulation.
ACCURACY AND STABILITY: Within ±0.02% of desired carrier frequency.
OPERATING TEMPERATURE: 0 deg to 55 deg C.
LINE VOLTAGE: ±10%.
LINE FREQUENCY: ±5%.
OPERATING POWER: 115 or 230 v, 50 or 60 cps, single ph.
HEAT DISSIPATION: 1510 W.

MANUFACTURER'S OR CONTRACTOR'S DATA

Radiomarine Corporation of America, New York, N.Y.
Contract Tcg-38556, dated 26 June 1951.

TUBE AND/OR CRYSTAL COMPLEMENT

(2) 3B28	(3) 12AT7	(2) 807
(4) 813	(2) 5R4WGY	(1) 12AU7
(2) 6AG7	(1) OA2	

Total Tubes: (17)
(4) CR-25/U
Total Crystals: (4)

REFERENCE DATA AND LITERATURE

Technical Manual for Radio Transmitting Set AN/URT-13.

TYPE CLASSIFICATION	
DESIGN COGNIZANCE	U. S. COAST GUARD
PROCUREMENT COGNIZANCE	
STOCK NO.	

UNCLASSIFIED

UNCLASSIFIED
August 1957

Radio-Transmitters
AN/URT-13

RADIO TRANSMITTING SET

SHIPPING DATA

NUMBER OF BOXES	CONTENTS AND IDENTIFICATION	VOLUME (Cu.Ft.)	OVERALL DIMENSIONS (Inches)	WEIGHT PACKED (lbs.)
1	Radio Transmitting Set AN/URT-13	54	34 X 37 X 74	990
1	Maintenance Parts Kit	12	23 X 30 X 30	360

EQUIPMENT SUPPLIED DATA

QUANTITY PER EQUIPT	NAME AND NOMENCLATURE	OVERALL DIMENSIONS (Inches)	WEIGHT (lbs.)
1	Radio Transmitting Set AN/URT-13 consists of:	24 X 27 X 63-5/8	840
1	Radio Frequency Tuner Assy TN-222/URT-13	18-3/16 X 21-1/8 X 23-1/2	50
1	Amplifier-Oscillator AM-854/URT-13	12-11/16 X 21-1/8 X 23-5/8	75
1	Radio Modulator MD-197/URT-13	11-3/8 X 21-1/8 X 23-1/2	135
1	Power Supply PP-965/URT-13	14-1/2 X 21-1/8 X 23-1/2	340
1	Cabinet, Electrical Equipment CY-1384/URT-13	24 X 27 X 63-5/8	240
1	M. O. Calibration Chart	3/32 X 8-1/2 X 11	
1	Box Maintenance Parts Kit	15 X 15 X 24	275
2	Set Servicing Diagrams	19-1/2 h X 10 W.	1
2	Technical Manual	3/8 X 8-1/2 X 11	4
1	Set Test Cables		5

UNCLASSIFIED

214.9 3 = 2000-15/1

TM-2000-15/

U. S. MARINE CORPS TECHNICAL MANUAL

MASTER MAINTENANCE REFERENCE MANUAL

DEPARTMENT OF THE NAVY · UNITED STATES MARINE CORPS

RADIO SETS AN/PRC-8, AN/PRC-9, AND AN/PRC-10

er 1961 Radio

GENERAL DATA		MAJOR UNITS
N:	5820-505-1827	(1) Radio Receiver-Transmitt RT-176/PRC-10
umber:	00086A	(1) Case CY-744/PRC
tion:	Two-way voice communications.	(1) Antenna AT-271/PRC
ufacturer:	Radio Corporation of America, Camden, N. J.	(1) Antenna AT-272/PRC
		(1) Handset H-33B/PT
tracts:	DA-36-039-SC-1391 DA-36-039-SC-9395	
roximate price:	$500.00	
ommended perational heckout nterval	DAILY	

ViewSonic

AN/PRC-8, -8A, -9, -9A, -10, -10A

From RadioNerds

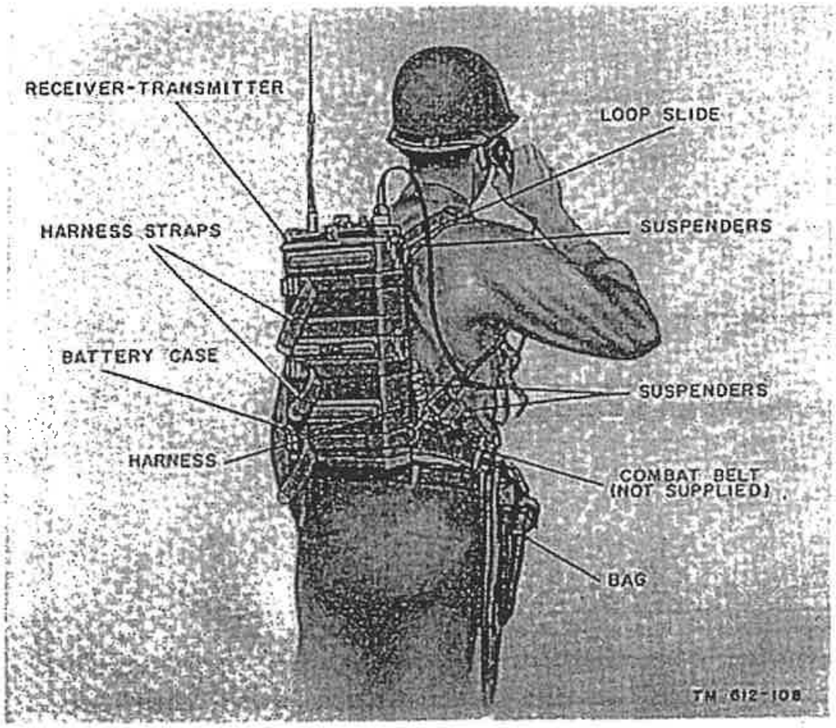


Figure 1. Radio set AN/PRC-8, -8A, -9, -9A, -10, or -10A, pack mounted.

Components

- RT-174 = PRC-8, 20 to 27.9 Mc. Armored
- RT-175 = PRC-9, 27 to 38.9 artillery
- RT-176 = PRC-10, 38 to 54.9 infantry
- ST-120 harness
- CY-744 battery case
- H-33/PT handset
- AT-271 ant 10 ' whip
- AT-272 ant. steel tape
- AB-129 ant. spring
- CW-216 antenna bag
- BA-279/U
- RC-292 ground plane antenna
- AM-598 amp./power for vehicle mount
- AN~GRA-6 remote

Additional Files

TM 11-612

Radio Sets

AN/PRC-8

AN/PRC-9
AN/PRC-10
September 1951

NOTE: This version contains a schematic, the 1954 version does not

TM 11-612

Operation and Organizational Maintenance

Radio Sets
AN/PRC-8
AN/PRC-8A
AN/PRC-9
AN/PRC-9A
AN/PRC-10
AN/PRC-10A
December 1954

TM 11-5820-292-20

Organizational Maintenance Manual

Radio Sets
AN/PRC-8, -8A, -9, -9A, -10, -10A, And -28
20 October 1961

TM 11-4065

Field Maintenance

Radio Sets
AN/PRC-8, -9, -10
September 1954

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- This page has been accessed 23,561 times.
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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-612

TO 31R2-2PRC-101

RADIO SETS AN/PRC–8, –8A –9, –9A, –10, AND –10A OPERATION AND ORGANIZATIONAL MAINTENANCE

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

DECEMBER 1954

AGO 2693A—Dec

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 67.5-volt or 135-volt circuits.

DON'T TAKE CHANCES!

100%

prc-9 or 9A?

Post Reply

4 posts • Page 1 of 1

shawneendn71
G-Civilian

prc-9 or 9A?

Thu Aug 07, 2008 4:26 pm

Hello, I'm new to this and would like if any one can give me some info. on this radio.It says on tag: radio rcvr-xmtr RT-175A/PRC-9, has a serial # and Radio Corporation of America (RCA?) Any info. would be a big help, Thanks!

moose53
G-Colonel

Thu Aug 07, 2008 5:00 pm

Radio set AN/PRC-9, frequency range 27.0 to 38.9 MHz, Super-Heterodyne FM Receiver / Transmitter. Man-Pack or Vehicular fixed station operation.1 Watt transmitter Output. Uses 16 miniature wire ended tubes. Power requirements 1.5V, 6V, 67.5V, 135V powered by BA-279 battery.

The AN/PRC-9 is part of a family of radios AN/PRC-8, AN/PRC-9, and AN/PRC-10 which were used as a squad radio by US Army in Korea and Vietnam Wars and by many NATO countries. Made in USA in 1950's and 60's, each radio had a different frequency range.

AN/PRC-8 >>>> 20.0 to 27.9 MHz
AN/PRC-9 >>>> 27.0 to 38.9 MHz
AN/PRC-10 >>>> 38.0 to 54.9 MHz

Jim

Zigzag50, Northeast51, KC2QDZ
MVPA # 30032, G838.org

1971 M151A2 1966 M416
1968 M101A1 1976 M116A1
1990 MEP-701A

Real Jeeps have horizontal grille slots!

Radtech
G-Major General

RT-175A

Thu Aug 07, 2008 5:20 pm

It is a PRC-9A which is electronicly different from the RT-175/PRC9.The Canadians and French coppied the electronics in some of their sets.The tube line up is different and it has a Pulse Sweep Generator that the RT-175 does not have.Also with the RT-175A you will have a sidetone audio in the receiver handset while transmitting while the RT-175 does not.

Dallas

wa5cab
CWO4 (Ordnance) USNR

Thu Aug 07, 2008 8:47 pm

Lest anyone question the nomenclature (to "A" or not to "A"), it's a quirk of the AN system that if a component began life with a specific component number and set assignment (in this case RT-175 and AN/PRC-9, making it RT-175/PRC-9), and was subsequently revised but kept the same component number it got a letter suffix (RT-175A) but kept the same set nomenclature (/PRC-9) even if it was a component of a revised set (AN/PRC-9A). Only if the revised component got a new number and was assigned as a component of a revised set did the set nomenclature get revised as well.

I can't think of an example pertaining to the PRC-8/9/10 family that illustrates the point but for example with the AN/ART-13 family of aircraft transmitters you had T-47/ART-13 which was the transmitter of AN/ART-13 and T-47A/ART-13 which was the transmitter of AN/ART-13A but T-412/ART-13B was the transmitter of AN/ART-13B. And O-16/ART-13 low freq oscillator for AN/ART-13 and O-17/ART-13A for AN/ART-13A.

Plus of course the rules weren't always consistently applied in either direction.

EXHIBIT K

not with regard to dust, for there is much here also, but with
regard to the length of exposure. The men in Bridgeport have been
exposed less than two years; therefore nothing would be revealed
by an examination of them.

I discussed my investigation of York with Mr. Clark
in Bridgeport, and he said he was perfectly willing to have the
examination of the four old employes in that plant carried out.

The third place in which asbestos is used, Schenectady,
is already under Dr. Vosburgh's supervision, and I did not take
that up.

My conclusion is that there is in both York and Bridge-
port an amount of asbestos dust large enough to be probably harm-
ful and eventually cause trouble. The only way to determine if
this is true is to see what effect years of exposure to it has had
on those exposed. I would, therefore, advise you to authorize Mr.
Overmeier to have X-ray pictures taken of the four men longest
employed. This can be done in York, but the films should go to
Dr. L. U. Gardner of Trudeau Sanatorium, Saranac Lake, New York
for interpretation. There is no one in York who is an expert in
this field, and Gardner is the foremost one in the country.

I enclose a statement of time and expenses covering a
two day conference in Saranac and visits to York and Bridgeport.

Sincerely yours,

Alice Hamilton M. D.

(Enc.)

L. W. Pearson. Schenectady. Jan. 20, 1934

Asbestos is used in the West Philadelphia plant. Dr. Minor says that he discovered a case of asbestosis and removed the man and that now the one man working wears a positive-pressure air helmet.

There are three men spinning asbestos in Schenectady, and there is an exhaust at the point of dust formation. Dr. Vosburgh has taken X-rays, which are negative.

The other plants in which asbestos is used are Bridgeport, York and Meriden.

L. U. Gardner advises taking X-rays. There is no other way.

The dust collects along the bronchios in animals, not in the lung tissue. There is a gradual growth of fibrous tissue around them, followed by occlusion and collapse.

Phagocytes with quartz particles move rapidly, collect in clumps and then undergo hyaline change, then necrosis. With granite dust the cells remain in the spaces, they do not form nodules. Probably there must be infection to make nodulation from granite dust, but not from quartz. Phagocytes with asbestos are crammed full of dust and hardly move. With carborundum dust they are more active. Quartz inhalations following injection of attenuated tubercle bacilli start a tuberculous process, so does carborundum, which seems to point to the probability that there is free silica in carborundum. The same result occurs if silicosis is first produced by inhalation and then the tubercle bacilli injected. There is more likely to be involvement of the bases of the lungs in silicosis-tuberculosis than in the usual form. Coal dust, iron ore, marble, and asbestos have no such effect.

PLAINTIFF'S EXHIBIT WV-05434

PLAINTIFF'S EXHIBIT 12/30/00

EXHIBIT L

109116

WILLIAM T. COVALESKI, et ux. Plaintiff (s) : COURT OF COMMON PLEAS PHILADELPHIA COUNTY

-vs- : MARCH TERM, 2003

ALLIED CORPORATION, et al. Defendant (s) : NO. 4332

- - -

Videotape deposition of WILLIAM T. COVALESKI, taken pursuant to notice, held at the Sheraton Park Ridge Hotel, 480 N. Gulph Road, King of Prussia, Pennsylvania 19406, on Tuesday, May 20, 2003, beginning at or about 11:20 a.m., before Wanda M. Barnum, Court Reporter and Notary Public, and Robert Higham, Videotape Operator, there being present.

- - -

APPEARANCES:

HOWARD, BRENNER & NASS
BY: EDWARD M. NASS, ESQUIRE
1608 Walnut Street
17th Floor
Philadelphia, Pennsylvania 19103
Phone: (215) 546-8200
Representing the Plaintiffs

McCARTER and ENGLISH, LLP
BY: EVOLEA C. WATSON, ESQUIRE
Mellon Bank Center
Suite 700, 1735 Market Street
Philadelphia, Pennsylvania 19103
Phone: (215) 979-3800
Representing Defendants,
AO Smith, Owens-Illinois, Inc.

APPEARANCES: (continued)

KELLY, McLAUGHLIN & FOSTER
BY: FRANCIS G. LaROCCO, ESQUIRE
1617 John F. Kennedy Boulevard
Suite 1690
Philadelphia, Pennsylvania 19103
Phone: (215) 790-7900
Representing Defendant,
Carrier

LAW OFFICES OF JOHN GUNHEIM
BY: MELODIE MEBANTA, ESQUIRE
Two Penn Center Plaza, Suite 1120
1500 John F. Kennedy Boulevard
Philadelphia, Pennsylvania 19102
Phone: (215) 988-9090
Representing Defendant,
John Crane

SWARTZ, CAMPBELL & DETWEILER
BY: WILLIAM ADAMS, ESQUIRE
1601 Market Street, 34th Floor
Philadelphia, Pennsylvania 19103
Phone: (215) 564-5190
Representing Defendants,
Brand Insulation and
Cleaver-Brooks

LAVIN, COLEMAN, O'NEIL, RICCI,
FINARELLI & GRAY
BY: JOSHUA A. GELMAN, ESQUIRE
510 Walnut Street, 10th Floor
Philadelphia, Pennsylvania 19106
Phone: (215) 627-0303
Representing Defendant,
General Motors

THORP, REED & ARMSTRONG, LLP
BY: ERIKA J. DOYLE, ESQUIRE
2010 Market Street, Suite 2430
Philadelphia, Pennsylvania 19103
Phone: (215) 563-6711
Representing Defendants,
Pfizer, Inc. and
Quigley Company, Inc.

APPEARANCES: (continued)

PHELAN, PETTIT & BIEDRZYCKI
BY: JEFFREY L. PETTIT, ESQUIRE
The Widener Building
One South Penn Square
Philadelphia, Pennsylvania 19107
Phone: (215) 575-4200
Representing Defendant,
Worthington Pump Corp.

SCHWABENLAND & RYAN, P.C.
BY: DENNIS B. STEPHENS, ESQUIRE
1700 Two Logan Square
Philadelphia, Pennsylvania 19103
Phone: (215) 988-1716
Representing Defendant,
Bickely, Inc.

PEPPER HAMILTON, LLP
BY: BARRY H. BOISE, ESQUIRE
3000 Two Logan Square
Philadelphia, Pennsylvania 19103
Phone: (215) 981-4000
Representing Defendant,
Volkswagen of America

JENKINS, ROBINSON, WOLF, HASSON, and STYLIADES
BY: GREGORY P. VOCI, ESQUIRE
Suite 500, Public Ledger Building
Philadelphia, Pennsylvania 19106
Phone: (215) 627-3087
Representing Defendants,
Vellumoid and Greene Tweed

MARSHALL, DENNEHEY, WARNER, COLEMAN & GOGGIN
BY: DAVID P. CZAP, ESQUIRE
1845 Walnut Street
Philadelphia, Pennsylvania 19103
Phone: (215) 575-2600
Representing Defendant,
Pep Boys

MARGOLIS EDELSTEIN
BY: LISA B. FLICKSTEIN, ESQUIRE
The Curtis Center
Philadelphia, Pennsylvania 19106
Phone: (215) 931-5893
Representing Defendants,
Sepco, Chapman Supply

APPEARANCES: (continued)

MARKS, O'NEILL, O'BRIEN &
COURTNEY, P.C.
BY: TIMOTHY D. RAU, ESQUIRE
1880 John F. Kennedy Boulevard
Suite 1200
Philadelphia, Pennsylvania 19103
Phone: (215) 564-6688
Representing Defendant,
Columbia Boiler

HOLLSTEIN, KEATING, CATTELL,
JOHNSON & GOLDSTEIN, P.C.
BY: MARK G. LIONETTI, ESQUIRE
1608 Walnut Street, Suite 1602
Philadelphia, Pennsylvania 19103
Phone: (215) 893-9488
Representing Defendant,
Hajoca Corporation

RAWLE & HENDERSON
BY: LAUREN MacMURRAY EVANS,
ESQUIRE
The Widener Building
One South Penn Square
Philadelphia, Pennsylvania 19107
Phone: (215) 575-4324
Representing Defendant,
Bendix

MARSHALL, DENNEHEY, WARNER,
COLEMAN & GOGGIN
BY: CHRISTOPHER SANTORO, ESQUIRE
1845 Walnut Street
Philadelphia, Pennsylvania 19103
Phone: (215) 575-2600
Representing Defendants,
American Standard, Weil McLain,
John Wood

WILSON, ELSER, MOSKOWITZ, EDELMAN
& DICKER, LLP
BY: DOUGLAS EISLER, ESQUIRE
The Curtis Center-Suite 1130 East
Philadelphia, Pennsylvania 19106
Phone: (215) 627-6900
Representing Defendants,
New York Steel Boiler,
A.W. Chesterton

APPEARANCES: (continued)

WILBRAHAM, LAWLER & BUBA
BY: BERNARD KUENY, ESQUIRE
Suite 3100, 1818 Market Street
Philadelphia, Pennsylvania 19106
Phone: (215) 972-2848
Representing Defendants,
Georgia Pacific Corp.,
Certain-Teed

MONTGOMERY, McCRACKEN, WALKER & RHOADS, LLP.
BY: CATHERINE PRATSINAKIS, ESQUIRE
123 South Broad Street
Philadelphia, Pennsylvania 19109
Phone: (215) 772-7222
Representing Defendant,
Selas Corp.

DUANE MORRIS, LLP
BY: NOLAN ATKINSON, ESQUIRE
One Liberty Place, Suite 4200
Philadelphia, Pennsylvania 19103
Phone: (215) 979-1000
Representing Defendants,
Chrysler/Ford

CREEDON & FELICIANI, P.C.
BY: JOSEPH L. FELICIANI, ESQUIRE
29 East Marshall Street
Norristown, Pennsylvania 19401
Phone: (610) 292-9000
Representing Defendant,
Gould Pumps

TIERNEY LAW OFFICES
BY: PATRICK T. FINNEGAN, ESQUIRE
100 S. Broad Street, Suite 1125
Philadelphia, Pennsylvania 19110
Phone: (215) 790-2400
Representing Defendant,
Bryan Steam

APPEARANCES: (continued)

LAW OFFICES OF SHERRY L. HOROWITZ
BY: SHERRY L. HOROWITZ, ESQUIRE
111 Presidential Boulevard
Suite 208
Bala Cynwyd, Pennsylvania 19004
Phone: (610) 667-0225
Representing Defendant,
Durabla Manufacturing Co.

JACK EMAS & ASSOCIATES
BY: JOHN J. BRANIGAN, ESQUIRE
1500 Walnut Street
Suite 1500
Phone: (215) 545-4770
Representing Defendants,
Peerless & Weinstein Supply

McGIVNEY, KLUGER & GANNON, P.C.
BY: MARQUIS JONES, ESQUIRE
1429 Walnut Street, 11th Floor
Philadelphia, Pennsylvania 19102
Phone: (215) 988-1707
Representing Defendant,
Sloan

Also Present: Dorothea Covaleski
Suzanne Salmon

asbestos with Igo?
A. No, I think that's about it.
Q. What was your next job after Igo?
A. I went with General Electric.
Q. Okay. And when was it that you started with General Electric?
A. 1956.
Q. Do you remember the month?
A. Yes, November.
Q. And is General Electric the company that you stayed with until you retired?
A. Yes.
Q. And I believe you told us --
A. Thirty-two years.
Q. And you retired in 1988?
A. Correct.
Q. So we have '56 to '88?
A. Yeah.
Q. Now, in November of 1956, which General Electric plant did you work at?
A. At the Space Division. It was a brand new division. It was the beginning of the space industry at 32nd and Chestnut.
Q. Okay. I guess this was right around the time that Russia put Sputnick up, right?

A. Yeah.
Q. Okay. And that General Electric plant you said was at what address?
A. 32nd and Chestnut Street.
Q. Is that plant still there today?
A. No. They moved out of there ten years ago and it was sold and I think it's condominium apartments.
Q. How long did you actually work at the GE plant at 32nd and Chestnut?
A. Twelve years.
Q. Until what year? You started in '56 there.
A. About '68, I guess.
Q. What was the size of the GE plant at 32nd and Chestnut?
A. It was a city block by two city blocks by ten stories high.
Q. And what were they actually making at this space division plant when you were there?
A. Nose cones for the missiles.
Q. When you started at General Electric in November of 1956, what was your first job?
A. Pipe fitter.
Q. And how long did you work as a pipe

fitter at that GE plant?
A. Approximately five years.
Q. That takes us up to what year?
A. '61.
Q. During those five years that you worked as a pipe fitter at General Electric, generally speaking, can you tell the members of the jury what your duties were?
A. The building was supplied with steam heat. And all steam pipe is covered with insulation, specifically with asbestos insulation. And that's three days out of five days I worked on the steam lines because I was either repairing or replacing or maintenance.
Q. Where were these steam lines in the facility?
A. They ran through -- there was a sixteen inch line that came in the building supplied by Reading Railroad. And then it branched off throughout the whole building. All the perimeters had wall radiators. And then when they were installing air conditioning through the whole building, each unit, which is approximately twenty ton units throughout the whole building, were supplied with steam coils

in there for heating.
Q. And as a pipe fitter at General Electric specific to this piping that ran throughout the plant, what were your duties?
A. Repairs, replacements, installation. There was always constant work on it. And you pulling off the insulation and then you would always patch it back up again. Or installation, if you ran a new line, you would automatically insulate it.
Q. Did you work on anything else there other than piping systems?
A. Yeah, plumbing.
Q. Did you work on any equipment, any types of equipment at the General Electric plant?
A. Yes.
Q. As a pipe fitter?
A. Yes.
Q. Give us some examples of the type of equipment.
A. Temperature, humidity chambers, which were pipe with water glycol. Anything that kept water or what have you going through it.
Q. Mr. Covaleski, in connection with your five years of work at the General Electric

plant as a pipe fitter between 1956 and 1961, were you exposed to any asbestos dust from any asbestos-containing products?
A. Quite a bit.
Q. All right. And can you describe to the members of the jury generally speaking how you would be exposed to asbestos in connection with this work?
A. First of all, with the asbestos covering. And most of the asbestos covering was made by --
MS. WATSON: Objection.
BY MR. NASS:
Q. You can't tell us right now the manufacturer's name. We'll get to that later. Go ahead.
A. It was pipe insulation. They called it half moon. And it came in various sizes, from half inch all the way up to sixteen inch. And there was a specific spot in the building, it was the penthouse on a roof they stored it because of the dust problem. And when the material came in receiving, they took it right up to the roof, and that's where it was stored, and they had racks with all different

sizes. And then they had fifty-five gallon drums and they had skids of loose asbestos, which you would tear open the bag and then dump it into the fifty-five gallon drum. And any time you had to mix some up, you would just get a two and a half gallon bucket and scoop out whatever you needed. And the floor was always covered with dust.

Q. Going back to that half moon insulation that you were describing -- first of all, how do you know that that product was made of asbestos?

A. It was an unwritten law in pipe fitting that anything that you had to do with steam had to have asbestos covering for the insulation purposes.

Q. Any other reasons that you know also that that pipe covering contained asbestos?

A. From day one it was the only thing available.

Q. Okay. The -- would you personally handle the pipe covering?

A. Oh, yeah.

Q. And would you have to do anything with that pipe covering before you installed it?

A. Cut it, fit it, mix up the loose asbestos for all the fittings and joints.
Q. What would you cut the half moon pipe covering with?
A. Saw.
Q. All right. And what would happen when you sawed the pipe covering?
A. All kind of dust.
Q. Would you breathe in that dust?
A. Yeah. Never had masks.
Q. You mentioned also the loose form of asbestos. What was that actually used for by pipe fitters?
A. To cover the joints.
Q. All right. And joints are what?
A. The elbows and the T's.
Q. Are you referring -- when you refer to elbows and joints and T's, are those parts of a piping system?
A. Piping system, yes.
Q. And did you personally mix loose asbestos?
A. All the time.
Q. All right. And what would happen when -- did that product come dry or premixed?

A. Dry.
Q. And what would happen when you mixed the dry substance?
A. It would just be so flaky. It would just carry right through in the air.
Q. In connection with your work as a pipe fitter at General Electric, were there any other types of asbestos-containing products that you personally handled other than pipe covering and loose asbestos?
A. Gaskets.
Q. Okay.
A. Sheet gaskets, pre-punched gaskets. Most of your fittings three inches or over were all flange gaskets and you would have premade gaskets, four hole, six hole, whatever the diameter and whatever the arrangements of the bolts were. Sometimes we would punch out our own gaskets. In most cases they would be premade pre-punched gaskets.
Q. And the gaskets were used where?
A. On the fittings where they bolted them together. You had two flush surfaces, and the gasket went in between to prevent it from leaking.

Q. We've talked about pipe covering. We've talked about loose asbestos. We've talked about gaskets. Any other types of asbestos-containing products that you personally handled?
A. Gaskets themselves for different type pumps, different type connections.
Q. Anything else that comes to mind right now?
A. String gasket, rope gasket. Any time you took a pump apart, obviously you replaced all the gaskets and replaced all the packing in there because you wouldn't reuse it again.
Q. The -- tell me what this rope product looked like.
A. It came in different diameters and strings. It was like a rope. That's why they called it. And then it was like an eighth of an inch in diameter. So if you were packing something and it was an eighth of an inch opening, you would just take one string and wrap it around until you got that area of packing material to where you want it. And then you would connect whatever connection it was to it.

If it were thicker than that half inch -- in most cases if you had like three-eighth or half inch, you'd get the regular packing material three-eighth or half inch by three-eighth -- half by half or half by three-eighths. But if not, you could use the rope material and wind it up and then pack it in there.

Q. All right. Going back to the gasket material you're talking about, you were talking about the sheet form of gasket. What would you have to do with the sheet form of gasket?

A. You would cut it to the size, whatever. Like say it's a six inch value, and you would cut a piece approximately eight inches or so. And if you had the valve there or something there, you could actually put it over and just with a ball peen hammer go around the edges inside and outside and all the bolt holes and just keep on tapping and -- otherwise, we had tools, different diameters for cutting the gaskets.

Q. And what would happen when you would cut the gasket material?

A. It would actually flake off.
Q. All right. And would you be exposed to that?
A. Oh, definitely.
Q. The -- going back now to the rope material and this string material, would you have to ever cut that?
A. Yes.
Q. All right. And what would you cut that material with?
A. With a knife.
Q. And what would happen when you cut the rope material?
A. Same way. It would fray at the ends.
Q. You've taken us up to as a pipe fitter. What happened in 1961?
A. I was promoted to foreman on second shift.
Q. Still at the same plant?
A. Still at the same plant.
Q. All right. And as a foreman, who were you supervising?
A. I was supervising plumbers, pipe fitters, electricians and carpenters. Complete maintenance group.

Q. All right. And how long did you work as a foreman of the maintenance group at that GE plant?
A. Approximately seven years.
Q. And what were your day-to-day duties as a foreman?
A. Supervising all the maintenance and repairs, get work orders, start the shift, hand the work out. And then during the night, we would go around checking on the jobs to make sure everything is running smooth.
Q. Now, during that seven-year period that you worked as a foreman, were you exposed to any asbestos dust from any asbestos-containing products?
A. Yeah, when the pipe fitters were working on steam lines, which it seems every night there was a job -- a repair job of some sort.
Q. The -- during that period from '61 to '68, were you doing any hands-on work or were you doing all supervision?
A. No.
Q. So then --
A. All supervision.
Q. All right. So during that period, you

would have not been personally handling the asbestos yourself?
A. Correct.
Q. Okay. In terms of the types of asbestos that your crew was using, was it similar or different than what you used as a pipe fitter?
A. Exactly the same thing.
Q. Where did you go to work for General Electric in 1968?
A. I was transferred up to Valley Forge.
Q. And how long did you end up staying at the Valley Forge facility all together?
A. Eighteen years in this one building.
Q. When you retired, were you working out of Valley Forge?
A. No. Yes, in Valley Forge, but I was in another building because it was the end of the coal war and we were making nose cones for the minuteman missile in that plant.
So, at the end of the coal war, the government stopped making minuteman missiles. So the plant -- the contract was cancelled and the plant closed. And then I went to another building for approximately two, three years before I retired.

EXHIBIT M

[As amended as of March 28, 1993]

TRANSACTION AGREEMENT

dated

November 22, 1992,

as amended as of February 17, 1993,

among

GENERAL ELECTRIC COMPANY,

MARTIN MARIETTA CORPORATION

and

PARENT CORPORATION

fully in the Baseline Study. Access to any report or information generated during the Baseline Study shall be limited to those employees of GE, MMC or Parent and their Representatives whose responsibility it is to determine the status of environmental compliance at any facility that is a Transferred Asset or at which MMC or Parent will conduct operations pursuant to this Agreement. Except as required by law or to effectuate this Agreement, no Person shall make any disclosure, publication or use of the results of the Baseline Study without the written consent of the respective general counsels of GE and Parent; *provided, however,* that GE or Parent may use such Baseline Study in the event of a dispute related to the Transaction Documents or in any action with a third party concerning the Baseline Study or conditions identified in the Baseline Study. Based on the results of the Baseline Study, MMC and GE will identify the actions necessary to correct each instance of Relevant Non-Compliance, the cost (net of any resulting tax benefit and net of any refund or reimbursement of any portion of such costs, including, without limitation, reimbursement by way of insurance, third party indemnification or the inclusion of any portion of such costs as a cost under Government Contracts) of which shall be borne by GE. If, before the date that is six months after the completion of the Baseline Study, MMC identifies additional instances of Relevant Non-Compliance that were in existence at the Closing Date but were not discovered by the Baseline Study, MMC shall so notify GE, which notice shall contain a description of such additional instances of Relevant Non-Compliance reasonably satisfactory to GE. GE shall have reasonable access to documents, persons and facilities to enable it to evaluate the facts contained in such notice. The cost of correction (determined as aforesaid) of any additional instance of Relevant Non-Compliance which is in excess of $100,000 shall be borne by GE. Any dispute concerning any instance of Relevant Non-Compliance or the action necessary to correct it shall be submitted for resolution to the Vice President for Corporate Environmental Programs of GE, to his counterpart at Parent, and to such third party as the two of them shall select, and their decision shall be final.

(b) Subject to any applicable privileges (including, without limitation, the attorney-client privilege), GE shall provide MMC reasonable access to documents, persons and facilities of GE from the date of this Agreement until the Closing Date during normal business hours and upon reasonable prior notice to enable MMC to evaluate the nature, scope and cost of any Remedial Action related to an Environment Liability. Without the written approval of the Vice President for Corporate Environmental Programs of GE, MMC shall not conduct any Remedial Action at any such location prior to the Closing Date. In the event MMC desires to conduct Remedial Action prior to the Closing Date, MMC shall notify GE of the nature, scope of and reason for such Remedial Action. GE shall determine in its reasonable discretion whether to permit MMC to conduct the requested Remedial Action, but GE shall give due consideration to any such request, including informing MMC of any modifications to such request that would make it acceptable to GE.

7.13. *KAPL Transfer Transaction.* On terms and subject to conditions substantially similar to those applicable to the Transfer Transaction set forth in this Agreement, on the Closing Date GE will transfer (or cause to be transferred) to Parent all assets owned or leased by, or in the possession of, GE or any Affiliate of GE and held or used primarily in the conduct of the KAPL business, as such assets shall exist on the Closing Date, and Parent will assume all liabilities arising out of the conduct of such business (the "KAPL Transfer Transaction"), in each case if such assets would constitute Transferred Assets if held or used primarily in the Business on the Closing Date or if such liabilities would constitute Assumed Liabilities if arising out of the conduct of the Business and in existence on the Closing Date. Apart from the assumption of such KAPL liabilities, there will be no adjustment to the Exchange Consideration as a result of the KAPL Transfer Transaction. As promptly as possible after the date of this Agreement, MMC and GE will prepare and execute mutually satisfactory documentation setting forth any additional mechanics or other terms as may be necessary to effect the KAPL Transfer Transaction.

ARTICLE VIII

TAX MATTERS

8.01. *Tax Matters.* The parties agree as to tax matters as set forth in Exhibit IV.

ARTICLE IX

Employee Benefit Matters

9.01. *Employee Benefit Matters.* The parties agree as to employee benefit matters as set forth in Exhibit V.

ARTICLE X

Conditions to Closing

10.01. *Conditions to the Obligations of Each Party.* (a) The obligations of Parent, MMC and GE to consummate the Closing are subject to the satisfaction (or waiver by GE and MMC) of the following conditions:

(i) Any applicable waiting period under the HSR Act relating to the Contemplated Transactions shall have expired or been terminated.

(ii) No provision of any Applicable Law or regulation and no judgment, injunction, order or decree shall prohibit the Closing, and no action or proceeding shall be pending before any court, arbitrator or governmental body, agency or official with respect to which counsel reasonably satisfactory to MMC and GE shall have rendered a written opinion that there is a substantial likelihood of a determination that would prohibit the Closing.

(iii) All actions by or in respect of or filings with any governmental body, agency, official or authority required to permit the consummation of the Closing shall have been obtained.

(iv) Parent and GE shall have executed and delivered the Standstill Agreement in the form of Attachment C.

(v) The Contemplated Transactions shall have been approved by MMC's shareholders to the extent required by Applicable Law and MMC's charter.

(b) The obligations of Parent, MMC and GE to effect the Transfer Transaction are subject to the additional condition that the Merger shall have been, or simultaneously with the Transfer Transaction shall be, consummated pursuant to the Merger Agreement (which shall be substantially as set forth in Attachment A).

10.02. *Conditions to Obligation of Parent and MMC.* The obligations of MMC and Parent to consummate the Closing are subject to the satisfaction (or waiver by MMC) of the following further conditions:

(a)(i) GE shall have performed in all material respects all of its material obligations under the Transaction Documents required to be performed by it on or prior to the Closing Date, (ii) the representations and warranties of GE contained in the Transaction Documents (except for the representations and warranties set forth in Section II.17 of Exhibit II) shall be accurate at and as of the Closing Date, as if made at and as of such date, except for any inaccuracies which, individually or in the aggregate, have not had or may not reasonably be expected to have, a Material Adverse Effect on the Business, (iii) the representations and warranties of GE set forth in Section II.17 of Exhibit II shall be accurate in all material respects at and as of the Closing Date as if made at and as of such date and (iv) Parent shall have received a certificate signed by an executive officer of GE to the foregoing effect.

(b) Parent shall have received an opinion of Davis Polk & Wardwell, special counsel to GE, or other counsel reasonably satisfactory to MMC, dated the Closing Date to the effect specified in Sections II.01 (other than with respect to the qualification to do business in any state other than New York) through II.03(a) and II.04(a) (with respect to clauses (i)(A) and (i)(B) thereof) of Exhibit II. In rendering such opinion, such counsel may rely upon certificates of public officers, as to matters governed by the laws of jurisdictions other than New York, Delaware or the federal laws of the United States of America, upon opinions of counsel reasonably satisfactory to MMC, and as to matters of fact,

upon certificates of officers of GE, copies of which opinions and certificates shall be contemporaneously delivered to MMC.

(c) Parent will have sufficient funds available to pay the cash portion of the Exchange Consideration for the Transferred Assets and will have obtained adequate working capital for the Business in an amount up to $500,000,000; *provided* that this Section 10.02(c) shall not be a condition to MMC's or Parent's obligation to consummate the Closing unless MMC shall have complied in all material respects with its obligations under Section 6.07.

10.03. *Conditions to Obligation of GE.* The obligation of GE to consummate the Closing is subject to the satisfaction (or waiver by GE) of the following further conditions:

(a) (i) MMC and Parent shall have performed in all material respects all of their respective material obligations under the Transaction Documents required to be performed by them at or prior to the Closing Date, (ii) the representations and warranties of MMC and Parent contained in the Transaction Documents (except for the representations and warranties set forth in Sections III.10A and III.04B of Exhibit III) shall be accurate at and as of the Closing Date, as if made at and as of such date, except for such inaccuracies which, individually or in the aggregate, have not had, and may not reasonably be expected to have, a Material Adverse Effect on MMC or Parent, as the case may be, (iii) the representations and warranties of MMC and Parent set forth in Sections III.10A and III.04B of Exhibit III shall be accurate in all material respects at and as of the Closing Date as if made at and as of such date and (iv) GE shall have received certificates signed by executive officers of MMC (as to MMC) and Parent (as to Parent) to the foregoing effect.

(b) GE shall have received an opinion of Dewey Ballantine, counsel to MMC and, at the time of the Closing, Parent, or other counsel reasonably satisfactory to GE, dated the Closing Date to the effect specified in Sections III.01A (other than with respect to the qualification to do business in any state other than Maryland) through III.03A(a), III.04A (other than clause (iii)) and III.01B (other than with respect to the qualification to do business in any state other than Maryland) through III.04B of Exhibit III. In rendering such opinion, such counsel may rely upon certificates of public officers, as to matters governed by the laws of jurisdictions other than New York, Maryland or the federal laws of the United States of America, upon opinions of counsel reasonably satisfactory to GE, and as to matters of fact, upon certificates of officers of Parent or MMC, copies of which shall be contemporaneously delivered to GE.

(c) The charter provisions governing the Preferred Stock (in the form set forth in Attachment D) shall have been, or simultaneously shall be, filed with the State Department of Assessments and Taxation of Maryland.

ARTICLE XI

SURVIVAL; INDEMNIFICATION

11.01. *Survival.* (a) None of the covenants, agreements, representations and warranties of the parties contained in any Transaction Document or in any certificate or other writing delivered pursuant to any Transaction Document or in connection with any Transaction Document shall survive the Closing except for those contained in Sections 5.03, 5.04, 5.05, 5.08, 5.09, 5.10, 5.12, 6.03, 6.04, 6.06, 7.01, 7.04, 7.06, 7.08, 7.09, 7.10, 7.11, 7.12 and 12.02 and Article XI and Article XIII of this Agreement, Section II.17 and Section II.18 (only with respect to actions brought against Parent, MMC or any other liable person in respect of the Proxy Material) of Exhibit II, Sections III.10A and III.04B of Exhibit III, Exhibit IV, Exhibit V (other than Section V.01), Sections 2.02, 2.03, 2.04, 4.01, 6.01 and 8.01 of the Transfer Agreement, those covenants and agreements of Parent relating to Parent's assumption of the Assumed Liabilities contained in the Exchange Agreement and referred to in the Transfer Agreement and those covenants and agreements set forth in any of the Transaction Documents which, by their terms, are to have effect after the Closing Date (each, a "Surviving Representation or Covenant"). It is understood and agreed that, except as explicitly provided in this Agreement, after the Closing there shall be no liability or obligation in respect of a breach or alleged breach of any representation, warranty, covenant and other agreement.

(b) Except with respect to the Excluded Liabilities and except as otherwise provided in this Agreement, Parent and MMC for themselves, their Affiliates and their respective agents, representatives, successors, assigns, officers and directors, effective as of the Closing, release and discharge GE, its Affiliates and their respective agents, representatives, attorneys, successors, assigns, officers and directors from any and all claims, demands, debts, liabilities, accounts, obligations, costs, expenses, liens, actions, causes of action (whether at law, in equity, or otherwise), rights of subrogation and contribution and remedies of any nature whatsoever, known or unknown, relating to or arising out of Environmental Liabilities or Environmental Laws.

11.02. (a) *Indemnification of GE by Parent and MMC.* Effective as of the Closing, each of Parent and MMC hereby indemnifies GE and its Affiliates, and to the extent actually indemnified by GE or any such Affiliate from time to time, its directors, officers, employees and agents, against and agrees to hold them harmless on an after-tax basis from any and all Damages incurred or suffered by any of them arising out of or related in any way to (i) any misrepresentation or breach of any Surviving Representation or Covenant made or to be performed by Parent or MMC pursuant to any of the Transaction Documents, (ii) the Assumed Liabilities (including, without limitation, Parent's or MMC's failure to perform or in due course pay and discharge any Assumed Liability) or (iii) any Financial Support Arrangement referred to in Section 6.04(b).

(b) *Indemnification of Parent and MMC by GE.* Effective as of the Closing, GE hereby indemnifies Parent and MMC and their respective Affiliates, and, to the extent actually indemnified by Parent, MMC or such Affiliate from time to time, their respective directors, officers, employees and agents against and agrees to hold them harmless on an after-tax basis from any and all Damages incurred or suffered by any of them arising out of or related in any way to (i) any misrepresentation or breach of any Surviving Representation or Covenant made or to be performed by GE pursuant to any of the Transaction Documents or (ii) the Excluded Liabilities (including, without limitation, GE's failure to perform or in due course pay and discharge any Excluded Liability).

11.03. *Indemnification of Parent and MMC by GE for Certain Assumed Liabilities.* (a) GE hereby indemnifies Parent and MMC and their respective Affiliates and, to the extent actually indemnified by Parent, MMC or such Affiliate from time to time, each of their respective directors, officers, employees and agents, against and agrees to hold them harmless on an after-tax basis from:

(i) in the case of any Matter described in clause (ii) of Section 11.03(b), Actual Net Expenditures; and

(ii) in the case of any Matter described in clause (i) or (iii) of Section 11.03(b), Actual Net Expenditures and Economic Harm (without duplication),

in each case only to the extent such Actual Net Expenditures were made by or such Economic Harm was actually realized by any of them before the tenth anniversary of the Closing Date, *provided, however*, that GE shall not have any obligation to indemnify with respect to any such Matter until the amount of such Actual Net Expenditures made or Actual Net Expenditures made and Economic Harm realized, as the case may be, exceeds $25,000,000 (each, an "Excess Amount"); and further provided that GE shall have received (1) notice from Parent specifying such Excess Amount and (2) evidence reasonably satisfactory to GE that Parent has made such Actual Net Expenditures or suffered such Economic Harm. Promptly after receipt of such notice and evidence, GE shall pay any Excess Amounts in cash or by wire transfer of immediately available funds to such account of Parent as Parent shall specify in a written notice. Any notice made pursuant to this Section 11.03(a) may not be delivered later than sixty days after the tenth anniversary of the Closing Date.

(b) For purposes of this Agreement, a single Matter shall consist of:

(i) Environmental Liabilities which arise out of a common root cause and which relate to the operation of the Business prior to, or the condition of the Transferred Assets as of, the Closing Date;

(ii) liabilities to the U.S. Government arising out of a common root cause, related to Government Contracts, and based upon allegations of knowing or intentional misconduct on the part of GE employees which occurred prior to the Closing Date in connection with the operation of the Business; or

(iii) Syracuse Environmental Matters which arise out of a common root cause and which relate to the condition of the Syracuse Electronics Park facility as of the Closing Date or GE's or its Affiliates' use or ownership thereof on or before the Closing Date.

(c) No Person shall be entitled to payment of any Excess Amount if, without GE's prior written consent, Parent (i) other than in good faith, rejected a settlement proposal in respect of such Matter or failed to settle such Matter for an amount that would have resulted in Actual Net Expenditures of less than $25,000,000 in respect of such Matter; (ii) settled any such Matter, or consented to the entry of judgment in respect of such Matter, where such settlement or judgment resulted in an Excess Amount; or (iii) did not allow GE to participate in a substantial manner with Parent in the defense of such Matter (substantially in the manner contemplated by Section 11.04(b)(ii)).

11.04. *Procedures.*

(a) *Notice.* GE agrees to give prompt notice to Parent of the assertion of any claim, or the commencement of any suit, action, proceeding or Remedial Action brought by a Person that is not a party hereto ("Indemnified Claims") in respect of which GE, its Affiliates, directors, officers, employees or agents seek indemnity under Section 11.02(a), after any officer of GE becomes aware of the facts giving rise to such Indemnified Claims. Parent agrees to give prompt notice to GE of the assertion of any Indemnified Claims in respect of which Parent, its Affiliates, directors, officers, employees or agents seek indemnity under Section 11.02(b) after any officer of Parent becomes aware of the facts giving rise to such Indemnified Claims. The failure of either GE or Parent to provide notice pursuant to this Section shall not constitute a waiver of that party's claims to indemnification pursuant to Section 11.02 in the absence of material prejudice to the other. Any such notice to Parent or GE shall be accompanied by a copy of any papers theretofore served on GE or Parent, as the case may be, in connection with the Indemnified Claims so satisfied. With respect to any Indemnified Claim asserted or brought prior to the Closing Date, notice of such Indemnified Claim shall be deemed to have been delivered on the Closing Date.

(b) *Defense and Settlement of Claims.*

(i) *Assumption of Defense by GE.* Upon receipt of notice from Parent pursuant to Section 11.04(a), GE will, subject to the provisions of Section 11.04(b)(iii), (iv) and (v), assume the defense and control of such Indemnified Claims but shall allow Parent a reasonable opportunity to participate in the defense thereof with its own counsel and at its own expense. GE shall select counsel, contractors and consultants of recognized standing and competence after consultation with Parent; shall take all steps necessary in the defense or settlement thereof; and shall at all times diligently and promptly pursue the resolution thereof. In conducting the defense thereof, GE shall at all times act as if all Damages relating to such Indemnified Claims were for its own account and shall act in good faith and with reasonable prudence to minimize Damages therefrom. Parent shall, and shall cause each of its Affiliates, directors, officers, employees, and agents to, cooperate fully with GE in the defense of any Indemnified Claim defended by GE.

(ii) *Assumption of Defense by Parent.* Upon receipt of notice from GE pursuant to Section 11.04(a), Parent will, subject to the provisions of Section 11.04(b)(iii), (iv), and (v), assume the defense and control of such Indemnified Claims, but shall allow GE a reasonable opportunity to participate in the defense thereof with its own counsel and at its own expense. Parent shall select counsel, contractors and consultants of recognized standing and competence after consultation with GE; shall take all steps necessary in the defense or settlement thereof; and shall at all times diligently and promptly pursue the resolution thereof. In conducting the defense thereof, Parent shall at all times act as if all Damages relating to such Indemnified Claim were for its own account and shall act in good faith and with reasonable prudence to minimize Damages therefrom. GE shall, and shall cause each of its Affiliates, directors, officers, employees, and agents to, cooperate fully with Parent in the defense of any Indemnified Claim defended by Parent.

(iii) *Continuing Notice of Certain Claims.* The party conducting a defense (the "Defending Party") pursuant to Section 11.04(b)(i) or (ii) shall give prompt and continuing notice to the other party or parties (each on "Indemnified Party") of any Indemnified Claims that the Defending Party reasonably believes may: (1) result in an Excess Amount subject to the provisions of Section 11.03; (2) result in the assertion of

criminal liability on the part of the Indemnified Party or any of its Affiliates, directors, officers, employees or agents; (3) adversely affect the ability of the Indemnified Party to do business in any jurisdiction or with any customer; or (4) materially affect the reputation of the Indemnified Party or any of its Affiliates, directors, officers, employees or agents.

(iv) *Settlement of Claims.* Subject to the provisions of Sections 11.03(c) and 11.04(b)(v), the Defending Party shall be authorized to consent to a settlement of, or the entry of any judgment arising from, any Indemnified Claims, without the consent of any Indemnified Party; *provided*, that the Defending Party shall (1) pay or cause to be paid all amounts arising out of such settlement or judgment concurrently with the effectiveness thereof; (2) shall not encumber any of the assets of any Indemnified Party or agree to any restriction or condition that would apply to such Indemnified Party or to the conduct of that party's business; and (3) shall obtain, as a condition of any settlement or other resolution, a complete release of each Indemnified Party.

(v) *Shared Defense.* Each party may elect to share the defense of an Indemnified Claim the defense of which has been assumed by the other party pursuant to Section 11.03(b)(i) or (ii). In that event, the Indemnified Party will so notify the Defending Party in writing. Thereafter, GE and Parent shall participate on an equal basis in the defense, management and control of any such claim. Parent and GE shall select mutually satisfactory counsel, contractors and consultants to conduct the defense or settlement thereof, and shall at all times diligently and promptly pursue the resolution thereof. Notwithstanding the foregoing, Parent shall manage all Remedial Actions conducted with respect to facilities which constitute Transferred Assets or at which MMC or Parent will undertake operations pursuant to this Agreement, *provided* that GE and its Representatives shall have the right, consistent with Parent's right to manage such Remedial Actions as aforesaid, to participate fully in all decisions regarding any Remedial Action, including reasonable access to sites where any Remedial Action is being conducted, reasonable access to all documents, data, reports or information regarding the Remedial Action, reasonable access to employees and consultants of Parent with knowledge of relevant facts about the Remedial Action and the right to attend all meetings with any government agency or third party regarding the Remedial Action. GE and Parent shall each be responsible for one-half of all Damages incurred after the Indemnified Party has provided notice as specified herein, including costs of defense and investigation, with respect to such claim, *provided, however*, that Parent's Actual Net Expenditures and Economic Harm with respect to any Matter governed by Section 11.03 shall in no event exceed $25,000,000.

(c) *Dispute Resolution.* If Parent and GE are unable to agree with respect to a procedural matter arising under Section 11.04(b)(v), Parent and GE shall, within ten days after notice of disagreement given by either party, agree upon a third-party referee ("Referee"), who shall be an attorney and who shall have the authority to review and resolve the disputed matter. The parties shall present their differences in writing (each party simultaneously providing to the other a copy of all documents submitted) to the Referee and shall cause the Referee promptly to review any facts, law or arguments either Parent or GE may present. The Referee shall be retained to resolve specific differences between the parties within the range of such differences. Either party may request that all oral arguments presented to the Referee by either party be in each other's presence. The decision of the Referee shall be final and binding unless both Parent and GE agree otherwise. The parties shall share equally all costs and fees of the Referee.

ARTICLE XII

TERMINATION

12.01. *Grounds for Termination.* The Transaction Documents may be terminated at any time prior to the Closing:

(i) by mutual written agreement of GE and MMC;

(ii) by either GE or MMC if the Closing shall not have been consummated by June 30, 1993; *provided, however*, that neither GE nor MMC may terminate the Transaction Documents pursuant to this clause (ii) if the Closing shall not have been consummated by June 30, 1993 by reason of the failure

CERTIFICATE OF SERVICE

The undersigned certify that a true and correct copy of the within Plaintiff's answer to Lockheed's motion for summary judgment has been filed electronically. The document is available for viewing and downloading from the ECF system and was served upon all counsel of record.

Robert E Paul

Robert E. Paul

Date: January 24, 2020